POWER

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Promoting Industrial Power Plants

SEVERAL operators have made a good thing for themselves and done a good thing for the electrical industry and the public, which it serves, by modernizing and rehabilitating out-of-date and inefficient electric stations.

There is a big opportunity for somebody to do the same thing for industrial plants.

The woods are full of industrial plants that have "just growed." Some of them have outgrown their right to continued existence. Comparatively few have been designed to take advantage of the high pressures and temperatures now successfully handled and to utilize the modern apparatus and processes now available.

A complete reorganization along modern lines, intelligently applying the more efficient appliances and practices that recent progress has developed to present needs and probable growth, would, in many cases, pay a rich dividend upon the required investment.

The present owners do not do it because they do not realize the possibilities; they haven't the money, or if they have, they can use it in increasing their productive capacity. They are getting along all right, and if they are losing money on their steam plants, they do not know it and it does not worry them.

But if somebody whose business it was to do such things would make a study of one of these wasteful examples, design the plant that would best meet the requirements of the establishment, put it in and take the notes of the purchaser for much of the purchase price, he would make a good profit on the apparatus sold and the work done, good remuneration for professional service, good interest on the money involved; and the purchaser could pay the interest on the notes and redeem them in a few years and come out with *a new and efficient plant paid for from its savings.*

A group of professional engineers, contractors, manufacturers of power-plant machinery and bankers would find profitable venture in this direction.

F. R. Low

Pulverized-Coal Installation Saves $6,300 in Six Months

By B. H. ROBERTS
Manufacturing Manager, Western Roofing Division, Bird & Son, Inc., Chicago

Unit pulverizers replacing oil firing on two return-tubular boilers make material reduction in operating expenses. On the fuel item alone the saving was $6,700. Efficiency of boiler plant with coal firing 75 per cent

AT THE Chicago plant of Bird & Son, Inc., the steam-generating equipment in 1926 consisted of two 72-in. by 18-ft. horizontal return-tubular boilers, oil fired, and the necessary auxiliaries. The oil burners were of the steam-atomizing type and had been operating for three years on heavy fuel oil with excellent results. In fact, operation had been so uniformly satisfactory with the oil equipment that the operators looked with just a little dread at a change to any type of coal-burning equipment.

The two boilers were set in battery with the shells

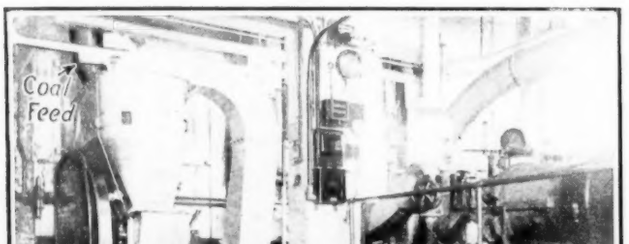


Fig. 1—Unit pulverizer serving west boiler

5 ft. 1 in. from the floor. A firing aisle 7 ft. wide ran in front of the two boilers. Ten feet above this aisle and partitioning it from the rest of the room, two curtain walls extended to the boiler-house roof, 35 ft. above the floor. Directly in front of the east boiler and just across the firing aisle was the turbine-generator equipment described in the Nov. 16, 1926, issue. The space directly in front of the west boiler was vacant. It can be realized that any contemplated change to coal-burning equipment would of necessity have to embrace dustless coal and ash handling in view of the other equipment in the same room.

A heavy oil having a specific gravity of 1.050 at 60 deg. F. and a heat content of 18,500 B.t.u. per pound was being used as fuel. This oil was delivered into the storage tanks at less than 5c. a gallon and the evaporation throughout the year averaged 14.2 lb. of steam per pound of oil from and at 212 deg. F. The steam load varied from 6,500 to 10,500 lb. an hour and was steady throughout the 24 hours of the day.

Late in 1926 it was found that fuel-oil prices for a contract covering a year's supply for 1927 would be approximately 20 per cent higher than the 1926 contract price. An immediate investigation was made as to the possibility of installing some type of coal-burning equipment. Owing to the necessity for dustless operation in the boiler room, the load to be carried and the problem of efficiency, it was useless to consider hand firing. Because of the cramped quarters directly in front of the east boiler and the lack of any room on the sides or in the rear, it was practically impossible to work out a satisfactory stoker installation with automatic ash dis-

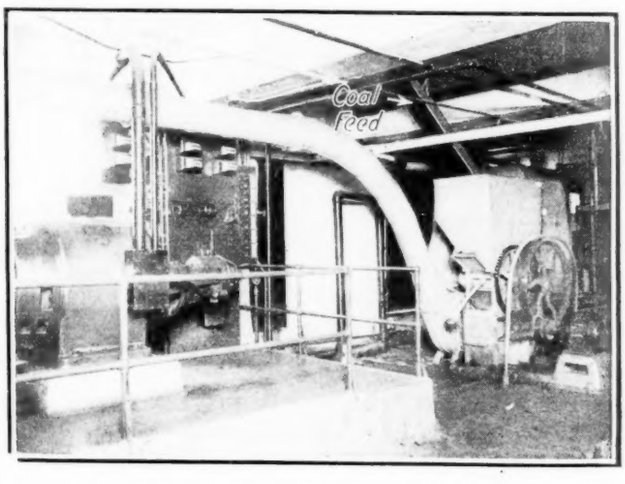


Fig. 2—Each pulverizer feeding over generator unit

posal. These considerations left pulverized coal as the alternative.

It was decided that one unit pulverizer per boiler with a capacity for 1,000 lb. of coal per hour would be sufficient. Upon checking the headroom and clearances, it was found that one pulverizer could be set directly in front of the west boiler and the other could be set 33 ft. in front of the east boiler, with the burner tube leading over the turbine platform and down to the burner. A 20-ton coal bunker could be placed between the two cur-

tain walls directly over the firing aisle and opening to the roof. This arrangement would allow coal to be spouted directly down to the west machine and at an angle of 43 deg. to the east machine. It was found that with a few alterations a swinging boom crane just east of the boiler room could be utilized for filling the bunker and unloading the coal to storage. Ash could be taken out the side door to the combustion chamber of each boiler and wheeled to a point reached by the swinging boom.

This program was entirely feasible and could be carried out at a minimum of expense provided sufficient volume could be obtained in the combustion chamber of the boilers. It was ascertained that 30 in. could be excavated under each boiler, thus providing a combustion chamber 21 ft. long, 7½ ft. from the shell to the floor

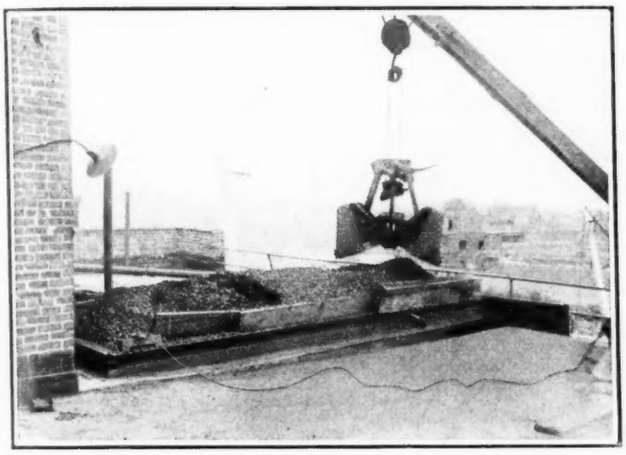


Fig. 3—Filling the bunker through roof opening

and 7 ft. wide. It was decided that by placing the burner 3 ft. below the shell, sufficient active combustion space would be provided for operation at 175 per cent rating.

On the basis of the foregoing plan it was decided to change over the boilers from oil to pulverized-coal firing. Two 1,000-lb. per hour machines were purchased and installed and the coal-handling equipment placed as described. The cost of the change over was approximately $9,000 complete, including all alterations.

On Nov. 1, 1926, the first boiler was placed in operation. It was found that this unit could operate at 175 to 200 per cent rating continuously, so the second boiler was shut down and converted to pulverized coal. Since this time the two boilers have operated alternately in five-week periods, continuously 24 hours a day and seven days a week. One boiler is operated for five weeks and is then shut down for a clean-out and the other one started up. It was found that there was sufficient room in the lower part of the combustion chamber for five weeks' accumulation of ashes, so no ashes are removed for this period.

During the first five months' operation, each boiler operated continuously at 180 to 200 per cent of rating without serious deterioration to the brickwork. Since that time each boiler has operated at 150 to 175 per cent rating continuously.

No trouble due to slagging has been experienced. During the fifth week of operation the top of the ash pile is slagged over to a depth of approximately 6 in., but this upper layer is easily broken through and offers no obstacle to ash removal. Approximately 75 per cent of the ash lodges in the rear half of the chamber, and it would be easily possible to remove this accumulation from the rear while the boiler is operating if there had been sufficient room for a cleanout door in this location.

It was found that a cold boiler could be brought up to pressure and operate at 200 per cent rating within 45 minutes after ignition. The stack is clear, and with normal handling it was practically impossible to make the installation smoke.

From Jan. 1 to July 1, 1927, the boilers evaporated 39,000,000 lb. of water from a feed-water temperature of 200 deg. F. The coal consumption during this period was 4,248,000 lb. of third-vein Indiana having a heat content of 12,500 B.t.u. per lb., as received. This corresponds to an efficiency of approximately 75 per cent.

Operation of the pulverized-coal apparatus is simple, and uniform conditions can be maintained. Coal is unloaded from cars to storage or to the bunker with the swinging boom crane. From the bunker it is spouted directly to the pulverizers. A comparison between the first six months of 1926, using oil, and the first six months of 1927, using pulverized coal, is made in the accompanying table. Approximately the same number of pounds of water were evaporated during both periods. There was no increase in boiler-room labor required with pulverized coal and the fuel handling labor was practically the same.

COMPARATIVE RESULTS FROM OIL VS. POWDERED COAL FIRING

	First Six Months 1926 on Oil	First Six Months 1927 on Pulverized Coal
Labor	$2,645.76	$2,506.27
Water, light, machinery and building maintenance	1,327.15	2,421.21
Fuel	14,300.24	6,696.01
Depreciation, insurance and taxes	1,943.20	2,298.59
	$20,216.35	$13,922.08
Saving in favor of pulverized coal		$6,294.27

The saving of $6,294.27 represents the actual reduction in operating expense and takes no consideration of the proposed 20 per cent increase in fuel-oil prices for 1927. Also the item of machinery maintenance shown under 1927 is high owing to the fact that some alterations were made in the boiler room during 1927 that were included under the heading of maintenance, but were actually a part of the installation cost of the pulverized-coal equipment.

It is to be understood also that the charges for maintenance, depreciation, interest and taxes cover all equipment in the boiler room, including the turbine-generator and switching equipment. No attempt was made to segregate items applying only to the pulverized-coal installation, since we were directly concerned with the actual reduction in operating expense.

NEW YORK CITY REFRIGERATING RULES require that every ammonia-compressor safety valve must discharge the ammonia in such a manner as not to endanger life or become a public nuisance. The discharge pipe must be carried at least ten feet above the highest opening in the roof of the building in which the ammonia compressor is located, and to an elevation at least ten feet higher than the roofs of adjacent buildings, provided such buildings have an opening or openings in the walls, through which ammonia may enter the interior of the buildings.

Attacking the Smoke Problem in St. Louis

By Osborn Monnett*

SURVEY shows atmospheric pollution in St. Louis to be greatest of twenty-four largest cities in the United States. Campaign of publicity and instruction achieving results.

DURING the last heating season, 1926-27, an effort was made to get together as much information as possible having a bearing on smoke in St. Louis. The following report is a summary of data on wind velocity, coal used, soot fall and distribution of the smoke.

In its direction and velocity the wind has a direct bearing on the smoke concentration over any given area. The curves show the average monthly wind velocity and direction for St. Louis. The highest wind velocities occur during January, February, March, April, November and December, which is an advantage, as higher wind velocity will more quickly scavenge the smoke over a given area if the rate at which the smoke is produced remains the same. However, the rate of smoke production is so greatly accelerated during the winter months that the higher wind velocity has no apparent effect.

There are times, particularly in December and January, when a state of stagnation occurs in the atmosphere, making the smoke density very marked over the city. At such times, the wind movement being at a minimum, the smoke forming this cloud is that produced in the immediate neighborhood. These periods of atmospheric stagnation will continue to occur whether or not smoke is present, and the only way to reduce their density is to reduce the amount of smoke produced in the territory.

Fuel Survey

Table I shows the amount of the various fuels burned in the metropolitan district of St. Louis. This represents as nearly as possible the tonnage consumed from April 1, 1925, to April 1, 1926. The fuel has been segregated into the various classes for purposes of study and also divided between the territories on the east side of the river and on the west. There is an additional amount of bituminous coal of about 750,000 tons not shown in this table, representing fuel shipped into the territory and then manufactured into other forms, and either used in the new form or shipped out to other places. This was left off the table to avoid repetition of tonnage.

Soot-Fall Study

In making a smoke study of any given territory, it is of advantage to make such observations as will determine the original atmospheric condition so that improvement may be measured year by year as the work goes on. One of the standard methods of doing this is by making a soot fall study in which precipitation of solid matter from the atmosphere is collected in suitable containers and measured from month to month throughout the heating season. The location of these containers is carefully chosen to give representative figures in all the typical neighborhoods of the community. For instance, in such a study the classifications include a railroad district, a manufacturing district, apartment house district, residence and suburban districts. In all there are fourteen locations within the city limits where soot fall is being collected in addition to various suburban locations, and three in East St. Louis.

Matter collected in the containers, which in this case are three-quart enameled ware buckets, is filtered and weighed. The material is then burned in a crucible, and the loss in weight, which represents the combustible material, is reported as soot. There may be some foreign matter which is of a combustible nature in the container, but such as is obviously of a non-fuel origin is eliminated before the weights are taken.

TABLE I.—FUEL SURVEY, ST. LOUIS AND SUBURBS

Industrial power plants, tons	1,422,000
Ceramic industry, tons	520,000
Railroads, tons	417,200
Office buildings, warehouses, hotels and large heating plants, tons	400,000
Hospitals and institutions, tons	141,000
Schools, tons	63,000
Large apartments, tons	262,500
Small apartments, tons	340,700
Two- and four-family flats, stores, garages and miscellaneous, tons	900,000
Residences, tons	464,300
Total bituminous coal	4,930,700
Coke—industrial and domestic, tons	233,000
Anthracite, tons	30,000
West Virginia smokeless, tons	3,000
Industrial oil, gal	15,000,000
Domestic oil, gal	30,000,000
Gas, cu.ft	8,323,649,000
EAST ST. LOUIS AND TRI-CITIES	
Industrial power plants, tons	1,739,000
Railroads, tons	509,900
Heating, tons	200,000
Total bituminous coal	2,448,900
Coke—metallurgical and industrial, tons	460,000
Industrial oil, gal	65,000,000
Gas, cu.ft	561,580,000
TOTALS FOR METROPOLITAN DISTRICT	
Bituminous coal, tons	7,379,600
Coke—Metallurgical, industrial and domestic, tons	693,000
Anthracite, tons	30,000
West Virginia smokeless, tons	3,000
Industrial oil, gal	80,000,000
Domestic, oil, gal	30,000,000
Gas, cu.ft	8,885,229,000

Weights of soot or combustible material are calculated in tons per square mile per annum. This is a standard figure that can be used in making direct comparisons with figures obtained elsewhere or with figures obtained at the same location at various periods.

For St. Louis the average winter soot fall for the season of 1926-27 is 870 tons per square mile per annum.

*Consulting engineer and specialist in smoke prevention work.

This average is taken from the four months of November, December, January and February—four normal winter months the figures for which represent most nearly true winter conditions.

These figures indicate that the atmospheric pollution in the Greater St. Louis district is higher than that in any other part of the country. The figure for Memphis, Tenn., including the entire heating season of 1925-26, was 600 tons. The figure for Chicago at the present time is 150 tons in the apartment districts as against 420 tons in the same type of district in St. Louis and 450 tons in the Chicago business district, as against 800 tons in the St. Louis business district.

Dust counter figures made by disinterested persons during the last year corroborate these figures. A series of readings shows that the concentration of impurities in the atmosphere in St. Louis was greater than in any of the twenty-four largest cities in the United States. In fact, St. Louis was at the foot of the list in this survey. It is to remove the soot or smoke (which is the same thing) from the atmosphere that our efforts are directed. The finely divided carbon acts as a mechanical carrier for sulphur gases, which, becoming oxidized to sulphuric acid, set up destructive action.

Ringelmann Chart Readings

Throughout the season systematic readings have been made to establish the average density of smoke made by the various classes of smokers. These readings cover all parts of the season at all hours of the day and represent the average performance of each class, establishing this figure as a standard for comparison, with similar figures which may be made in the future. The density, as determined by these observations, is shown in Table II.

TABLE II.—AVERAGE SMOKE DENSITY OF VARIOUS CLASSES OF SMOKERS IN ST. LOUIS

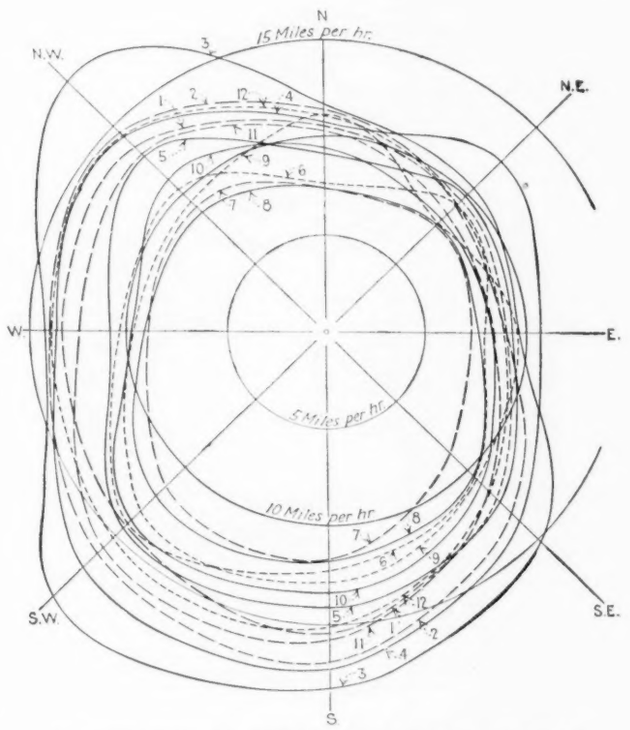
	Per Cent
Brick yards	43
Factories and miscellaneous power plants	16
Railroads (locomotive operation)	18
Railroads (including round houses)	20
Office buildings and large heating plants	23
Hospitals and institutions	10
Schools	11
Large apartments (over 6 families)	19
Small apartments (6 family)	14
Two- and four-family flats and miscellaneous	8
Residences	6
AVERAGE SMOKE DENSITY—EAST ST. LOUIS	
Industrial	37
Railroad	26
Domestic	7

Patrol Work

Before attempting smoke-abatement work on heating plants on a large scale, it was decided to select certain localities for experimental work in order that some idea could be obtained as to the value of such work.

As a demonstration several locations were selected, including all classes of smokers, such as apartment houses, flats, stores, garages, residences, etc. One of these was at Kingshighway and Page Boulevard. On one side was a row of residences and on the other side a row of two-family flats. The smoke density of the locality was carefully determined by a series of Ringelmann chart readings taken before the people in the territory were aware of the work. After the density had been determined for the territory, the patrol work was begun, literature was distributed on proper methods of firing, and individual instruction to householders and those who operated the furnaces. After three days' work the density of the territory was again determined and showed a reduction of 55 per cent in the residence smoke and 45 per cent in the two-flat building smoke. However, the comparison at this time, so far as weather conditions were concerned, was not so favorable, as the original density was obtained when the outside temperature was at 30 deg., and the second density when the temperature was 10 deg. above zero. There was, however, such a noticeable improvement in the district that another locality was selected and comparisons carefully made under exact weather conditions. This locality consisted of a row of residences all equipped with hot-air furnaces. A smoke reduction of 79 per cent was obtained after three days.

In dealing with householders, it has been found that about 90 per cent are willing to co-operate; some do not care to have the demonstrators come into the basement, but promise to read the instructions and follow them; others gladly welcome the visit of the firing instructor. In either case it has been our experience that marked improvement results.



Average monthly wind velocity and direction for 1918 to 1925, St. Louis, Mo.

The third territory selected for demonstration was at Skinker, Pershing and Waterman, extending to River Des Pere, containing a stretch of six blocks, with all classes of smokers from single residences to 24-family apartments, stores, garages, a hotel, etc. The original condition was obtained as above, and then instruction was begun. After one week the reduction in apartments was 65 per cent, and in residences 59 per cent. This was not considered satisfactory as far as residences were concerned, and further work was done. After another week of instruction the apartments showed 67 per cent and the average reduction for all readings on residences showed 72 per cent.

In this district the experiment was tried of using student instructors from Washington University. Six of them were employed, each having a block, and patrolling the district from 6:30 in the morning until 8, and from 4 to 5 in the afternoon. It was found that the student instructors were not very successful with the janitors, as the latter considered them merely students, without much experience, and did not take them seriously. The regular men had much better success with the janitors. All janitors who had not already been at the firing school, were urged to go there and were given instructions and then followed up through the day by the regular men. However, the student instructors had better success with the householders. They distributed their literature and then returned to give instructions in case it was desired. It was found also that it was better to take this matter up with the janitors early in the morning while they were firing and had the work on their minds. On the contrary, our experience has been that in the case of residences, a better reception is given instructors in the afternoon.

Distribution of Smoke

From the data collected in this investigation it is possible to fix the relative responsibility of each class of smoker in relation to the total smoke produced. The following figures are based on the heating season of 1926-27. Taking first the territory as a whole, including the East Side, the city proper and suburbs, the division of smoke is as follows:

	Per Cent
Industrial smoke	63
Heating smoke	26
Railroad smoke	11
	100

Naturally, the large industrial works on the east side of the river, where the factories are allowed to smoke as much as they please, cause industrial smoke to overshadow all other classes when viewing the territory as a whole. We find, however, that the wind direction is such as to minimize the importance of a great deal of this smoke.

Considering the west side of the river as a unit, including the city itself and suburbs, the importance of heating smoke increases with a corresponding decrease in industrial smoke. The proportion becomes:

	Per Cent
Industrial smoke	50
Heating smoke	42
Railroad smoke	8
	100

The heating smoke in the foregoing classification, representing 42 per cent of the city's total smoke, may be divided into large heating plants 30 per cent and small heating plants 12 per cent. All the readings taken together emphasize the importance of the large plant.

Suggestions for Procedure

As far as brickyards are concerned, there are well-known furnaces available for this kind of work—furnaces that have been used successfully in other places. Considerable interest is now being shown and some improvements started.

With regard to factory power plants there is no reason why rapid progress should not be made in this branch of the problem. This is the part of the work that has best been worked out and standardized, and there is no question about obtaining successful results when the problem is given proper study.

The group of smokers represented by apartments, large heating plants and two- and four-family flats and miscellaneous plants, constitute 34 per cent of the entire smoke problem. It is in this class as a whole that the greatest showing should be made in the patrol work.

It was noticed when making railroad observations that the worst smoke was produced by engines standing still on side tracks or parked in yards. By inaugurating closer watch over such cases, the railroad smoke could be cut materially. Roundhouses are making a great deal of smoke, and smoke washers should be urged to do away with this part of the problem.

Pressure, Volume and Temperature Chart*

THE volume of a given weight of gas changes with any variation in either its temperature or pressure. The relations that exist among the pressure, volume and temperature of a gas have long been known, and were first stated in the laws of Boyle and Charles. According to the law derived by Boyle, the volume of a perfect gas diminishes in the same ratio as the pressure upon it is increased, provided the temperature remains constant. The law of Charles states that the volume of a gas at constant pressure is proportional to its absolute temperature. If, for convenience, the volume of a gas is considered to be unity at the standard conditions of 32 deg. F. and atmospheric pressure, 14.7 lb. per sq.in. absolute, these two laws may be expressed by the equation $PV = \frac{14.7T}{492}$, where P is the pressure in pounds per square inch, V the volume expressed in terms of the volume at 32 deg. F. at 14.7 lb. per sq.in. pressure, and T the absolute temperature.

The accompanying chart is designed to solve this equation, and the three co-ordinates correspond to the three variables—pressure, temperature and volume. It is based on the properties of the isosceles triangle which states that the sum of the perpendiculars to the sides of the triangle from any point within the triangle is equal to a constant. By using logarithms, the equation for a perfect gas becomes $\log P + \log V + \log \frac{1}{T} = \log \frac{14.7}{492}$, and in this form it satisfies the properties of the isosceles triangle.

The chart will be found convenient in solving various types of gas problem. For example, suppose it is desired to find the density of air at 45 lb. per sq.in. absolute and 300 deg. F. Enter the chart along the pressure line corresponding to 45 lb. pressure and follow it until it intersects the horizontal line corresponding to 300 deg. From this intersection follow the volume line to the bottom scale where it is found that the volume of the gas under these conditions is 0.5 of the volume at standard conditions. The table shows the density of air at 32 deg. F. and 14.7 lb. pressure to be 0.0807, and thus the density at the desired condition is $\frac{0.0807}{0.5} = 0.1614$.

Manufacturers of compressors frequently give the

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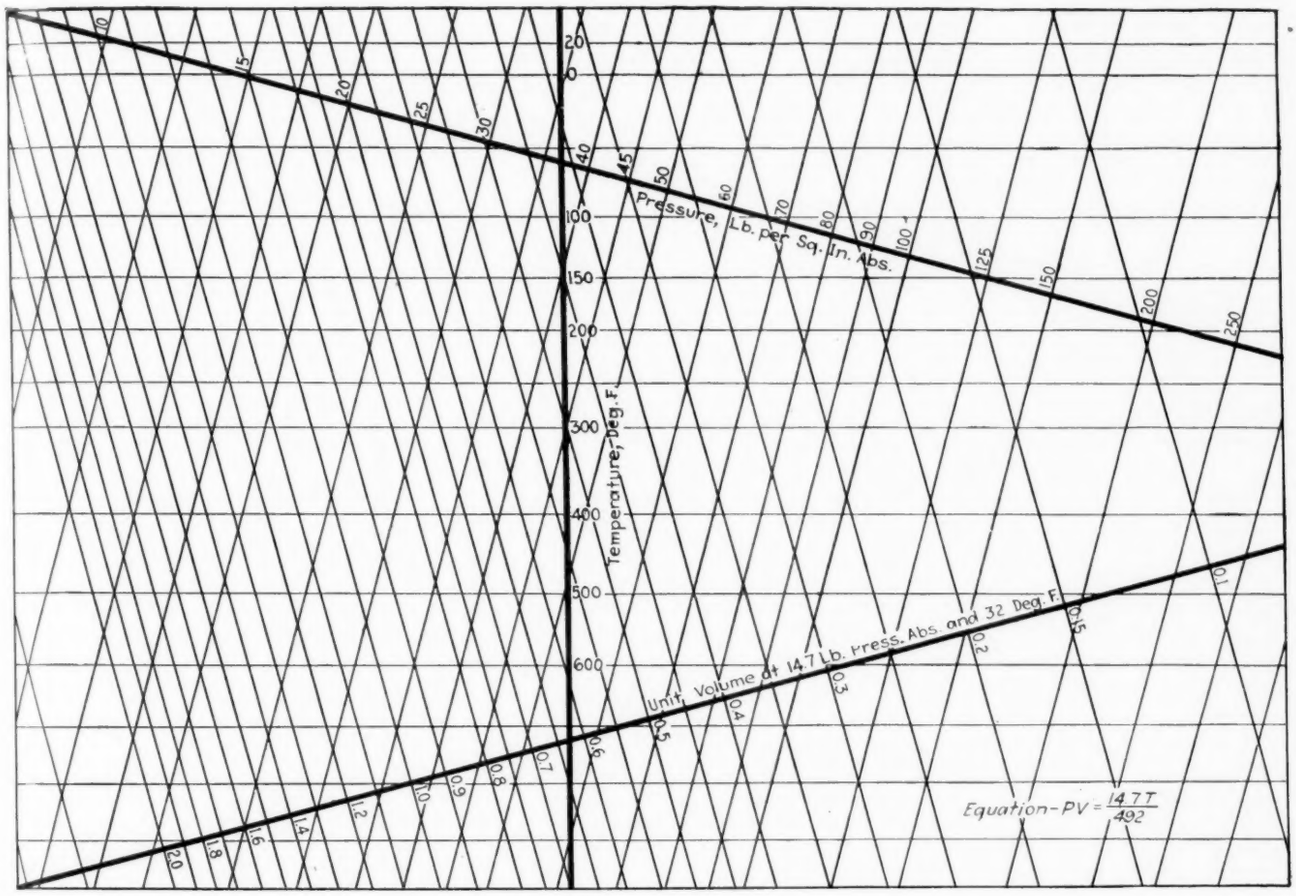
capacity of their equipment in cubic feet of free air per minute, while the user is more often interested in the cubic feet of compressed air delivered. The chart will be found helpful in converting cubic feet of free air to compressed air. Thus if a compressor is able to compress 30 cu.ft. of air per minute at standard conditions engineering calculations, as most gases follow these laws closely within the range of the chart.

A chart similar to this was published in the April issue of the French publication *Arts et Metiers*. The scales, however, were marked off in metric units, and the three axes made equal angles with each other. By changing



Pressure, volume, temperature chart for gases

to 100 lb. per sq.in. absolute and 100 deg. F., the cubic feet of air delivered may be found from the chart as follows:

Using the chart as previously described, it is found that the volume of air at 100 lb. pressure and 100 deg. F.

DENSITY AND SPECIFIC VOLUME OF GASES AT ATMOSPHERIC PRESSURE AND 32 DEG. F.

	Lb. per Cu.Ft.	Cu.Ft. per Lb.
Air	0.0807	12.38
Oxygen	0.0892	11.209
Hydrogen	0.0055	178.93
Nitrogen	0.0783	12.77
Carbon monoxid	0.0780	12.81
Carbon dioxide	0.1226	8.15
Acetylene	0.0725	13.79
Ammonia	0.0475	21.03

is 0.17 of its volume at standard conditions. Therefore, the volume of compressed air delivered will be 30 × 0.17, or 5.1 cu.ft. per minute.

Although the chart is based on the laws governing perfect gases, it will be found that the results obtained from its use will be sufficiently accurate for ordinary the angle between the co-ordinate axes it was found possible to lengthen the temperature scale. This improvement makes it possible to read the chart with greater accuracy and ease.

IT IS DESIRABLE TO PROVIDE synchronous motor control equipment with both alternating-current and direct-current ammeters. From the alternating-current ammeter the operator can regulate the field excitation for unity power factor at any load, at which the machine may be operating. The direct-current ammeter enables the operator to provide normal field excitation as given on the motor nameplate and, with the manual starters, to determine when the motor has accelerated to the proper speed for applying the field. The power factor meter is not so necessary a part of the equipment as the ammeters, but is quite desirable in that the operator can determine at a glance the power factor at which the motor is operating. This is particularly desirable if the operator wishes to adjust the motor's power factor.

INTERNAL COMBUSTION ENGINES

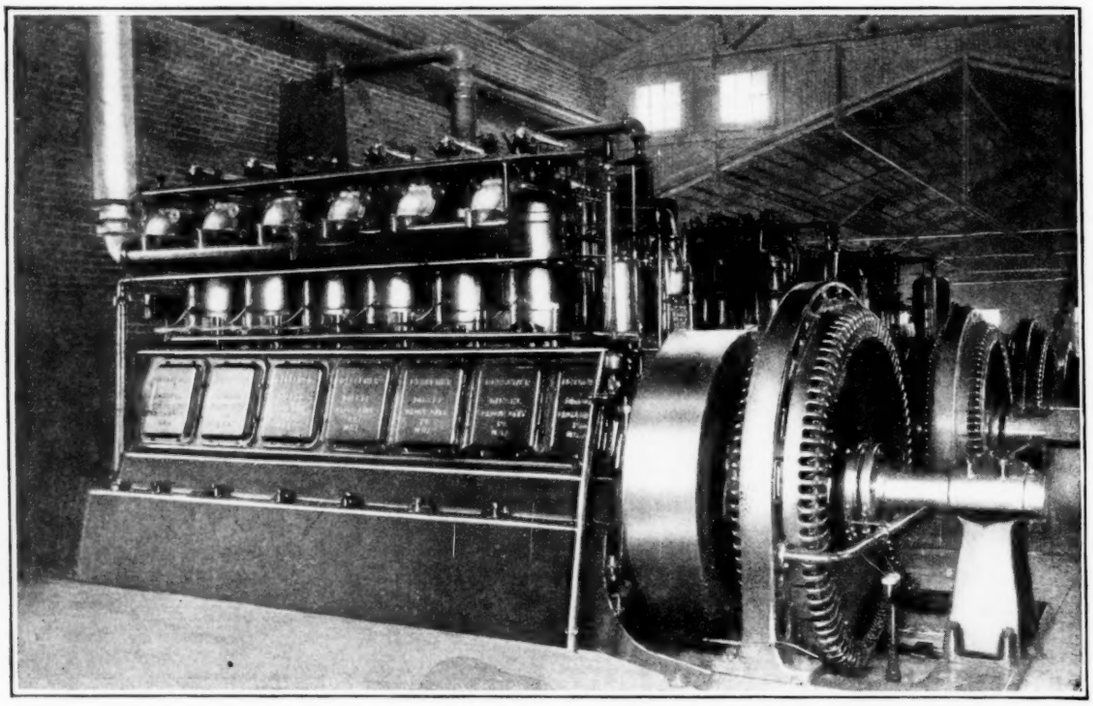


Fig. 1—Three 360-hp. Diesels were installed in the new Grove City plant

Modernizing a Municipal Light Plant

By FRANK H. POEHLMAN
Superintendent, Electric Light Plant, Grove City, Pa.

Grove City, Pa., Builds New Light Plant—Old Gas Engines Replaced by Diesels—Fuel Cost Is Cut One-Half—Plant Has Many Safety Features

IN MANY instances a municipality obtains its control over the generation and distribution of electricity at some economic sacrifice. Grove City, Pa., has a more fortunate history, for since the installation of the original municipal light plant the operation has been exceedingly satisfactory, as to both continuity of service and operating costs.

The first plant was put in operation in 1908, and as natural gas was abundant, a 150-hp. gas engine was the prime mover. This was augmented the following year by a 100-hp. similar unit, followed by another addition in 1913. In 1920 the mounting demand in electrical consumption required a further addition in plant capacity. Natural gas was decreasing in availability, and this prompted the purchase of a 185-hp. Bessemer semi-Diesel engine with a suitable generator, and in 1922 a second oil engine of the same make was placed in service.

In 1924 the plant had about reached its limit as to output, and either additional equipment had to be added or a new plant constructed. Due study into the comparative operating costs of the gas and oil engines proved conclusively that the oil engine produced power at the lower cost, and future fuel-oil supply was removed from the bounds of uncertainty. Consequently, I was instructed to design and build a new plant using Diesel engines, which were more economical in fuel consumption than semi-Diesels and were capable of being constructed in larger powers.

Three Bessemer solid-injection four-stroke-cycle Diesels of 360 hp. each, direct-connected to 375-kva. gen-

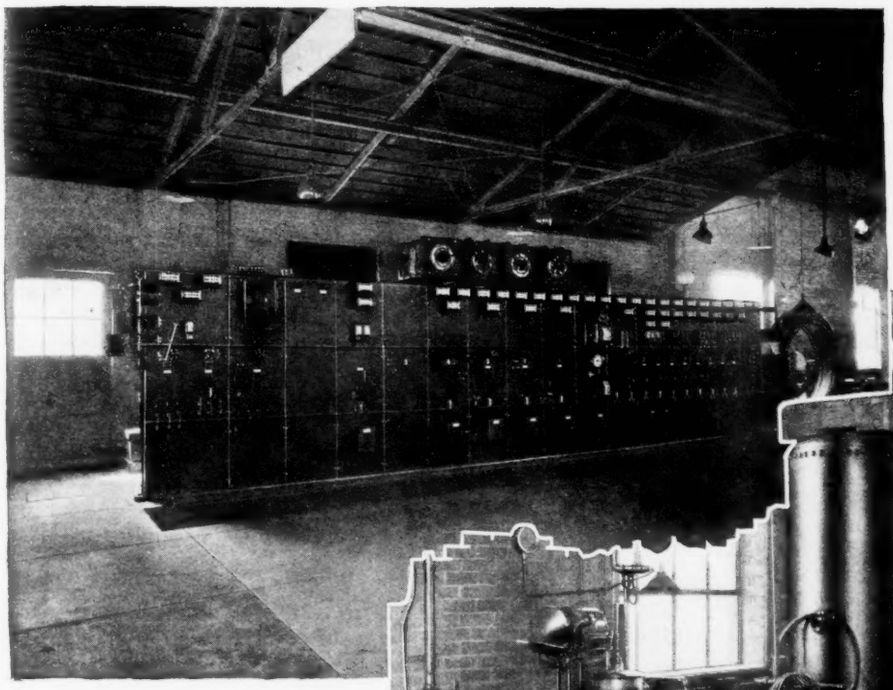
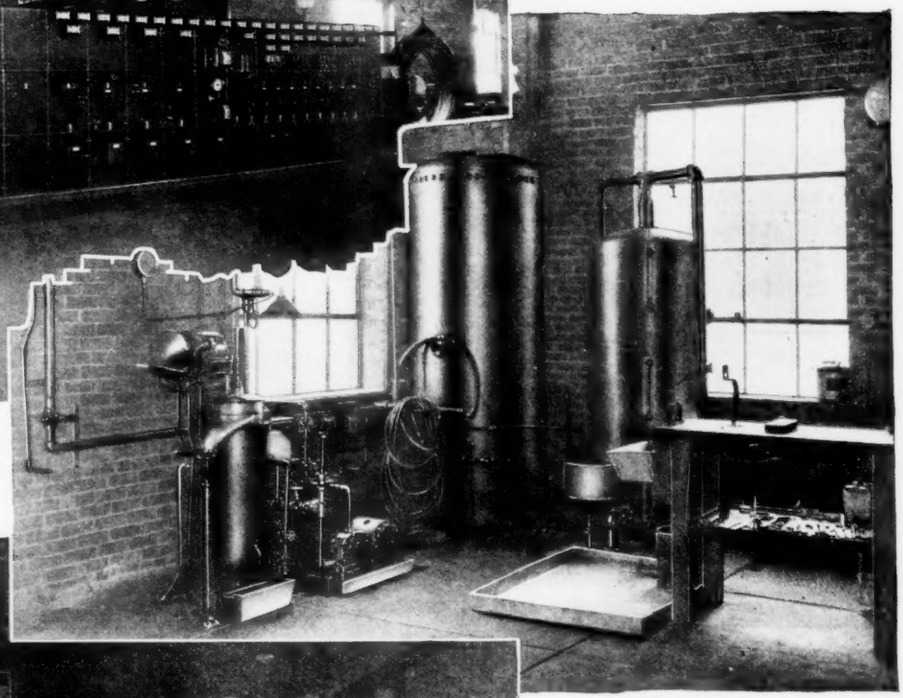


Fig. 2 (Above)—View of the switchboard

Fig. 3 (Below)—A centrifuge reclaims the oil



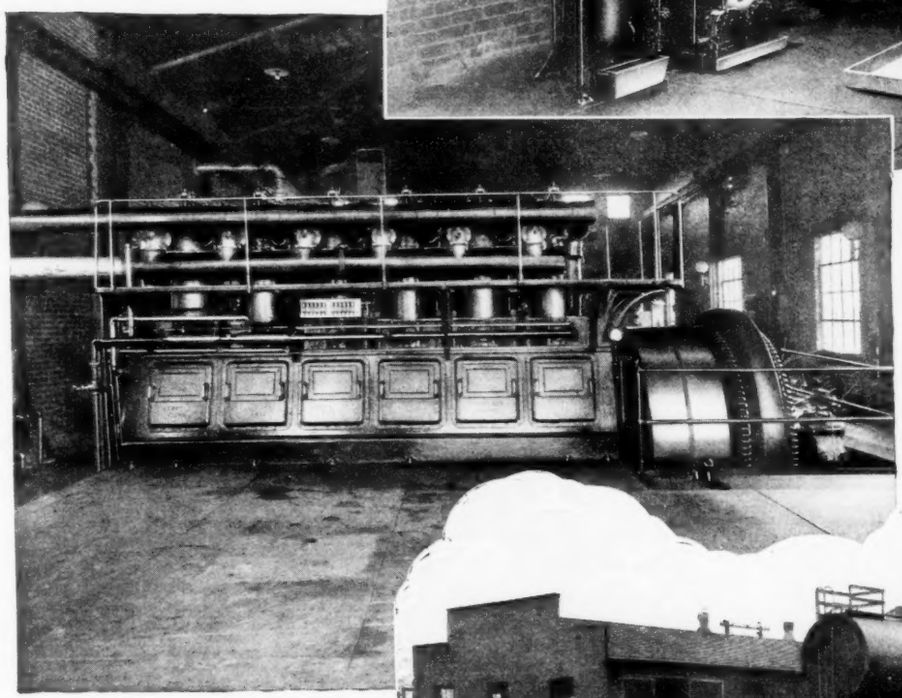


Fig. 4 (Left)—750-kva. unit installed in 1927

Fig. 5 (Right)—The oil storage and cooling pond

INTERNAL COMBUSTION *Engines*

erators operating at 277 r.p.m. were installed in a new location and the old plant entirely scrapped. The number of customers increased each year, and in March of this year it was necessary to install an 800-hp. Diesel of the same make, direct-connected to a 750-kva. 240-r.p.m. 2,300-volt generator. This unit, shown in Fig. 4, is notable in that the generator rotor is of welded construction, consisting of a forged ring and hub with a connecting plate web or disk.

Excitation is obtained from two 225-ampere motor-generator sets, one of which is motor-driven from the primary bus, and the second motor obtains its current through the station transformers. Emergency excitation is obtained from a gas-engine-driven generator consisting of an ordinary Ford motor which, minus transmission, is connected to a 5-kw. generator.

The Switchboard Is Complete

The switchboard, Fig. 2, consists of one swinging panel, one 2-circuit exciter panel, one regulator panel, one indicating light panel, one secondary feeder panel, five generator panels, one main panel, one synchronous condenser panel, two 2-circuit street lighting panels, three 2-circuit primary feeder panels, and one street lighting panel controlling two circuits of curb lights. The swinging panel has two primary voltmeters, one direct-current voltmeter, one power-factor meter, one frequency meter and a synchroscope. Each generator panel is equipped with one indicating wattmeter, one phase ammeter with a three-point switch, one direct-current ammeter and an integrating wattmeter. The main panel has one indicating wattmeter, one indicating ammeter with three-point switch, one recording voltmeter, one recording demand meter and one recording and one integrating wattmeter. The exciter panels have indicating ammeters and the regulator panel is equipped with a Terrill K4 regulator. The synchronous condenser panel has standard equipment. Street lighting panels carry one indicating wattmeter, two indicating 10-ampere meters, and one integrating wattmeter each. Feeder panels have one indicating phase ammeter with a three-point switch and one indicating wattmeter per circuit.

Circuit breakers are protected by overload and inverse time-limit relays, as well as by telltale lights and a bell alarm operated by a bell-alarm relay through the direct-current bus. The effort was made when designing the plant to make the operation of the electrical portion of the plant as nearly automatic as possible. Consequently, generator panels have telltale light and bell protection indicating for each generator unit loss of lubricating oil pressure, rise in cooling-water temperature, rise in temperature of end main and outboard bearings.

The same system is connected to the main lubricating oil tank, giving protection against loss of head on the oil lines to the several engines, as we use a common outgoing line to all engines with gravity pressure to force-feed pumps. Lights for this tank, together with lights for the receiving well and standpipe, are mounted on the indicating panel, on which we are now also mounting flow meters for the water-works pumps, as our building also houses the municipal water plant.

Fuel requirements are taken care of by two 15,000-gal. tanks with two 10,000-gal. tanks in reserve, shown in Fig. 5. The fuel flows by gravity from the main tanks through a strainer and a meter to a centrifuge. After being centrifuged, it is pumped to a day tank from which it flows by gravity through a fuel-oil header to the engines.

Each engine is equipped with a duplex lubricating pump taking oil from the main oil-header and returning it through a return header to the tank. The oil is by-passed from the tank to the centrifuge, where, after clarification, it is returned to the main lubricating tank.

Cooling water for the engines is taken care of by a 200 g.p.m. centrifugal pump, which, taking its water from an outside 11,000-gallon tank, forces it through the engines, then through spray nozzles back into the tank.

Economies of the New Plant

Owing to the change from the old to the new plant, marked economies were effected. In the old plant the water, after being used, was wasted. In the new plant the cooling system uses but 6,000 gal. of makeup water a day. In 1924 the cost of water was $6,387.80, which was reduced to $520.14 in 1926.

The combined fuel bill for gas and oil when operating the old plant was $29,967.58 in 1924, during which time we produced 2,152,740 kw.-hr. In the new plant 2,669,500 kw.-hr. were produced during 1926 at a cost of $16,948.64.

A comparison of the difference between 1924 and 1925-6 as shown in the tabulation demonstrates the savings we have been able to accomplish.

	1909	1920	1924	1925	1926
Energy generated, kw.-hr.		1,327,944	2,152,740	2,288,100	2,669,500
Plant expense	$3,940.00	$23,743.98	$59,861.74	$26,024.74	$32,900.95
Sinking fund		10,730.90	3,989.13	22,658.92	18,630.28
Outside lines, etc.					
Net income	$4,556.99	.....	$89,455.88	$91,308.94	$94,826.24

The operating costs are well balanced, those for January, 1927, being as follows:

EXPENSE

Salaries	$562.50	Heat	15.00
Wages	205.25	Telephone	1.15
Fuel	1,621.76	Plant lights	94.37
Oil	387.36	Miscellaneous	60.41
Water	16.20		
Repairs	161.63		$3,124.63

Other small economies have been effected. Drips from the fuel pumps have been recovered, the meter showing over 1,000 gal. saved per month, with an average of $0.07 per gal. The centrifuge, Fig. 4, which we installed with our last unit at a cost of $1,300, returned an initial saving of 800 gal. of reclaimed crankcase oil which we had accumulated between the time of ordering and delivery of same and now, besides centrifuging our fuel oil and clarifying our lubricating oil, it also cleans the waste oil, which is pumped from the wheel pits to a tank equipped with heaters, where, after heating and clarifying, the oil is returned to the lubricating system. If the oil is not worth cleaning, we pump it direct to the fuel tank. This has resulted in the recovery of about 60 gal. of lubricating oil per month. Finally, we have equipped all our engines with air cleaners and while a saving is not to be calculated directly due to them, they

INTERNAL COMBUSTION *Engines*

undoubtedly will lengthen the life of the cylinders, bearings and spray valves.

The city is also installing a filter plant in connection with the water system, and the alterations are such that all pumping will be done at the off-peak period of from midnight until 7 a.m., thus removing a 140-kw. load from both the daylight and night load peaks. This will tend to lighten the present peak load curves and raise the light load curve. In addition, we have recently connected to our lines a 225-hp. synchronous motor-generator set with an 80 per cent leading power factor, which is used from midnight Saturday until Monday 6 a.m. This helps the light Sunday load period and gives some power factor correction.

Financial Position of the Plant

The financial statement of the electric department of the borough as of Jan. 15, 1927, is as follows:

Valuation, as of Jan. 1, 1926	$226,455.01
Extensions in 1926	8,420.19
New building	7,418.48
Payment on new unit	3,845.25
	$246,138.93
Less depreciation reserve	11,743.76
	$234,395.17
Outstanding indebtedness	75,544.00
Net valuation	$158,851.17

In municipal operations of any kind the final results of any savings finally revert to the taxpayers, so we have reduced our income through rate reductions approximately $700 a month beginning Jan. 1, 1926. Since both the electric and water plants are under one roof, the power costs for water pumping have been reduced 1c. per kw.-hr., or one-third. One pumper at $120 per month has been dispensed with, resulting in a substantial reduction in water-plant operation. This in turn has been passed on to the taxpayer in the form of rate reductions, and when the new off-peak pumping schedule goes into effect, the rate will again be reduced by 1c. Finally, any decrease in cost per kilowatt-hour is reflected in cost of street lighting, which is billed to the general fund at cost.

Solving the Power Problem of a Summer Resort

By G. Grow

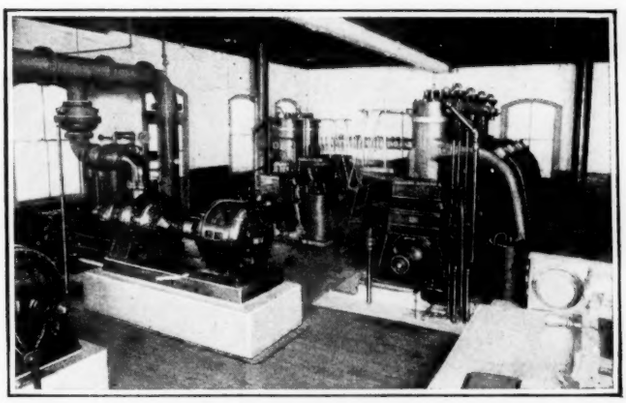
THE problem of supplying water, light and power to a summer resort is often puzzling as to the choice of the energy source. Such consumers are by no means attractive to the central stations since the load exists for but a small portion of the year. To cover the necessary investment charges, the energy rates must be high. Since the load during the summer season is centered in the evening hours with but a small day energy consumption, steam equipment is not always economical and oil engines are often installed.

Mackinac Island, at the extreme northern top of the Michigan lower peninsula, has been a summer resort for years. The water and electricity were supplied from a steam plant which, however, proved expensive to operate when labor and coal rates increased during and after the War.

In 1923 a 200-hp. Diesel was installed to drive the generator previously belted from a steam engine. This was followed in 1925 by a 240- and an 80-hp. Diesel direct connected to alternators, this increase permitting a second steam engine to be shut down.

The management states that while the steam plant was in good condition it found the fuel cost so expensive that, without the change to oil power, rates would have had to be increased to the detriment of the community. F. B. Doherty, the secretary of the light company, states:

> The only trouble we ever had with the oil engines was in the first two months we operated the first one. We had some piston trouble which I found was caused by inexperience on our operator's part and by the grade of lubricating oil that we were using. We got this straightened out, and since that time we have never had a minute's trouble. During the summer months this engine has run twenty-four hours a day for as high as four weeks at a time without a shutdown. The new engines installed have never caused us any trouble and carry a full load and at times a considerable overload.
>
> During the winter the load is light and we run the 80-hp. unit 24 hours a day with a shutdown once every two weeks for cleaning, which takes from two to three hours. We find it a good practice to clean the exhaust of carbon every two weeks. Sometimes we find considerable carbon and other times very little. This depends a great deal on the temperature at which the engine is run. If the operator runs it with the jacket water too cold, the exhaust ports become more carbonized than if run at the proper temperature.



Two of the three Fairbanks-Morse Diesel engines together with the pumps in the power house

As a result of the favorable experience in the use of Diesel engines for the main power plant on the Island, the Grand Hotel has recently placed an order for a 180-hp. Diesel generating set of the same make, which will be installed to take care of the power load and the lighting of the hotel. This plant will be arranged so that it can be paralleled with the light company's lines and in the event of an emergency can take care of the pumping and any other part of the load up to the limit of the plant capacity. This arrangement will offer greater protection to the Island, particularly to the water works, as the two plants are widely separated, giving assurance that in case of fire at either place the Island will not be in total darkness.

INTERNAL COMBUSTION *Engines*

When Does a Bearing Pound in an Internal Combustion Engine?

By L. H. Morrison

THIS is a discussion of bearing pressures, intended to show that current ideas as to when a bearing pounds are erroneous. While the Otto cycle gas engine is used as an illustration, the reasoning applies to all gas engines.

ALL who have operated oil engines, or for that matter any reciprocating engine, know that if the connecting-rod bearings are given too much clearance they will pound. But just what makes them pound and at what point in the cycle the pounding occurs is not so clear.

Discussing the wristpin only, at first, most operators will say that with a four-stroke-cycle single-acting engine no pound can occur on the power stroke since the wristpin is in contact with the one side of the bearing during the entire stroke and on the following exhaust stroke the piston is forced back with the pin still pressing against the same side of the bearing. It is at the end of the exhaust and beginning of the suction stroke that the pound occurs, so many assume, since at this point the pin leaves its contact with the bearing side to make contact with the opposite side of the bearing.

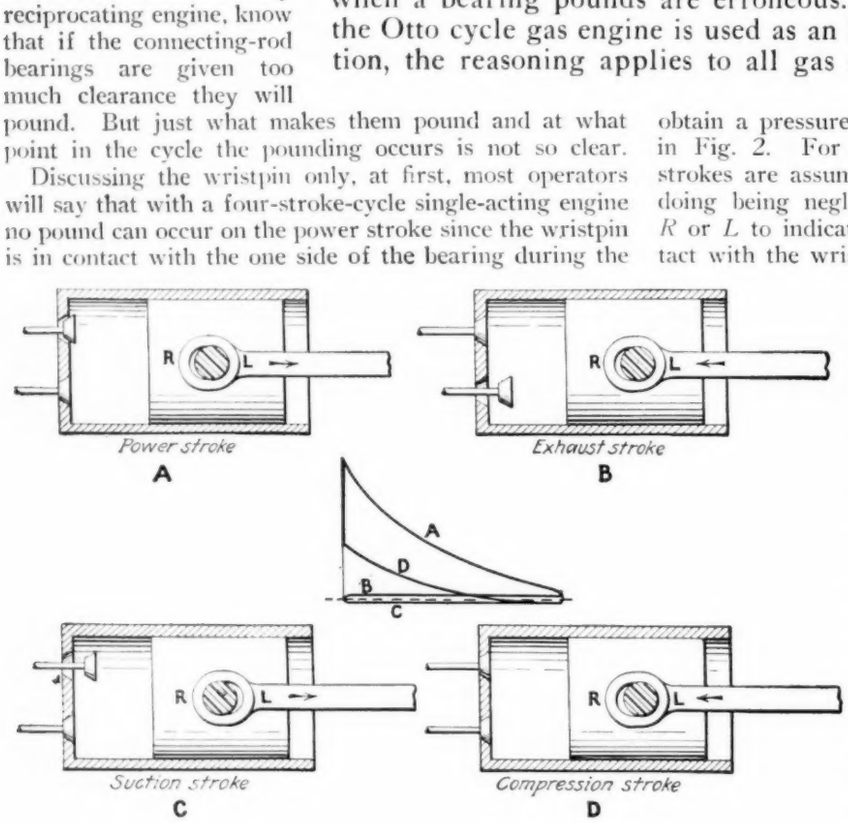


Fig. 1—Point of wristpin contact with its bearing of gas pressure was the only force present

The assumed conditions are shown in Fig. 1. A piston position is shown for each of the four strokes with the pin in contact with either the bearing side *L* or *R*. In addition, in the center has been placed a typical gas-engine indicator diagram showing the lines that would be drawn by the indicator pencil during the four strokes.

If these pressures be laid out along a line, we obtain a pressure curve for the four strokes, as shown in Fig. 2. For convenience the exhaust and suction strokes are assumed to be atmospheric, the error by so doing being negligible. The four strokes are marked *R* or *L* to indicate which half of the bearing is in contact with the wristpin.

On the face of it the bearing should pound when the direction of bearing pressure apparently changes at the end of the suction stroke. But this is not the state of affairs, as another factor creeps in to destroy the entire argument. This factor is inertia.

It requires power to start and bring an automobile up to speed, and power, in the shape of braking action, is developed in slowing it down. In the same way a force must be exerted to bring an engine piston up to its maximum speed and then to slow it down as it nears the end of its stroke.

This acceleration and slowing down require a force to be exerted. It is obvious that during the early part of the stroke, provided no other force existed save that used to perform the acceleration process, the crank and rod would pull the piston and during the slowing down process the piston would exert a force on the connecting rod and wristpin. The force necessary to overcome the inertia of the piston in acceleration can be calculated by the equation

$$F = \frac{WV^2}{gr}\left[\left(\cos a + \frac{\cos^2 2a}{n}\right)\right]$$

when a = crank angle; r = crank throw; n = rod to crank ratio; V = velocity of the crankpin; W = weight of reciprocating parts; and g = acceleration due to gravity, feet per second per second. Using this formula and inserting the values pertaining to a particular engine,

INTERNAL COMBUSTION *Engines*

the forces necessary to overcome the inertia at all points in the stroke can be calculated and laid out as shown in Fig. 3. At that part of the stroke where the inertia force curve is below the base line, the force is negative—that is, it resists the piston motion—and when above the line, the inertia force assists the continued piston travel. The curve has been constructed for all four strokes, and marked *R* and *L* to indicate which side of the bearing the wristpin is in contact with if there were no gas pressure on the piston. Assuming that no other force is present, such as when the engine is running idle, it will be noticed from Fig. 3 that the pressure on the bearing reverses at approximately mid-position in each stroke. The distance the curve is above or below the base line is proportional to the intensity of the force in pounds per square inch of piston area, in order to make it to the same scale as the indicator diagram in Figs. 1 and 2.

If we combined Figs. 2 and 3, we would obtain the net force tending to move the piston on its stroke. For example, during the early part of the power stroke the force necessary to overcome the piston inertia resists the force due to the gas expansion, and as a consequence the net force tending to turn the crank through the agency of the connecting rod is diminished, and during the remainder of the stroke the net power is increased by the inertia force. A combination for the four strokes gives the net force diagram shown in Fig. 4.

It will be seen that during the entire power stroke a positive force is applied to the rod and the pin is always in contact with the left side of the bearing. During the exhaust stroke the net force is negative during the first portion and positive during the second portion of the stroke. The pressure of the wristpin changes from the left to right side of the bearing at about the center of the stroke, but the change is so gradual that unless the clearance be excessive no pounding will occur. The same applies to the suction stroke.

During the compression stroke the mean-effective pressure is at all times negative, and at no point in the stroke does the positive inertia force equal the negative gas pressure. Consequently, the net force curve is negative during the entire stroke, with the pin in contact with the left side of the bearing.

On the next power stroke the pin pressure remains at the left, so that no reversal occurs at the end of the compression stroke, but the value of the total force is increased at dead center, owing to the combustion of the gases.

It is clear, then, that the wristpin cannot pound at the ends of any stroke. It can do so near the center of the suction and exhaust strokes, but only if the clearance is large.

A lighter piston would cause the inertia force curve to be flatter, resulting in a lesser pressure change during these two strokes. Clearances with light-weight pistons can then be greater. Conversely, a heavier piston or a higher speed would make the curves steeper and the more rapid pressure change would require closer clearances to avoid pounding. To offset high speeds, light pistons are necessary.

It is interesting to note that if a gas engine having heavy reciprocating parts should operate on a low load or have a leaking piston, the net-force diagram during the compression stroke may have a different shape from that shown. Instead of a negative value during the entire stroke, the curve may cross the zero line near the end of the stroke. This would cause pounding at the end of the compression stroke. In one case the curve crossed the zero line twice in the stroke, producing two distinct thumps.

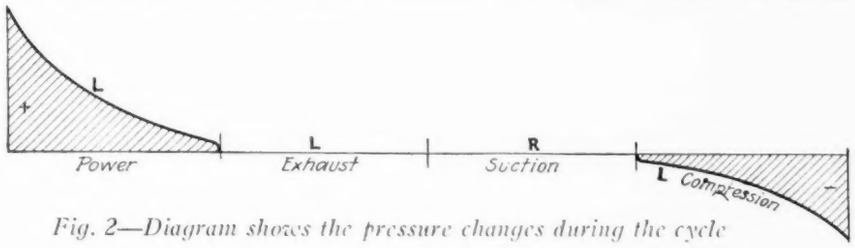


Fig. 2—Diagram shows the pressure changes during the cycle

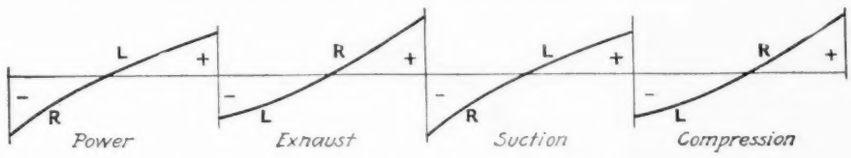


Fig. 3—The inertia of the reciprocating parts results in the introduction of another force

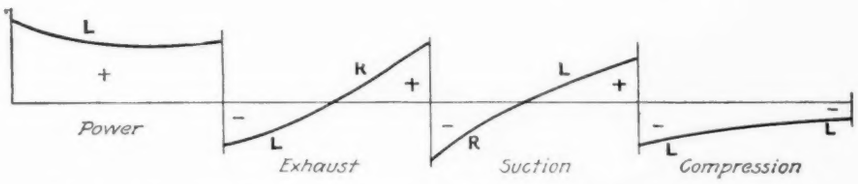


Fig. 4—The combined gas and inertia forces give this net-force diagram

THE EXHAUST PIPES OF OIL ENGINES should be of cast iron, as steel pipes corrode rapidly, especially when the fuel oil contains an appreciable quantity of sulphur. The sulphur burns to sulphur dioxide, which may be oxidized to the trioxide in the engine cylinder and combine with the water vapor of combustion to form sulphurous or sulphuric acid. The exhaust gases should never be cooled to the condensing point of water, which would cause corrosion.

ELECTRICAL *Operation and Maintenance*

Repair Versus Replacement of Old Transformers

A Method for Determining Which Is the More Economical, To Repair an Old Transformer That Has Failed or Replace It With a New One

By MAURICE D. SMITH

ON THE lines of electric light and power companies and in industrial plants distribution transformers are used in large numbers. Some of these transformers have probably been in service for years, and occasionally, for some reason, it is found necessary to make repairs. Since repair work costs good American dollars, it is one of the engineer's jobs not to spend them uneconomically. Hence, there must be some economic transformer repair cost, and it is the object of this article to pass along to others an economic study, curves, and the method employed by an Eastern company to determine an economic transformer repair cost.

The main operating cost of a transformer is its core loss and is therefore an important factor when deciding whether the transformer should be returned to service once it has been removed from the lines for repairs. During the last thirty years manufacturers have made important increases in the efficiency of transformers. This has been made imperative by competition and the constant demand of the users for more efficient equipment at lower costs.

Table I shows the results obtained by one manufacturer since 1896, and while there is a large decrease in core loss, the copper loss has been increased slightly. However, the core loss is more important, since the transformer is generally energized for 24 hours each day, thus making the core loss constant, while the copper loss varies with the secondary load. This, of course, reaches a maximum for only a few hours each day.

By referring to Table I and comparing the core loss of a 10-kva. transformer manufactured under column No. 1 with the same transformer manufactured under column No. 5, which is relatively recent, it is seen that the core loss has been more than cut in half, having been reduced from 139 to 62 watts. It is therefore important to consider the question of core loss before making repairs. The figures in column 1 do not tell the whole story, since, as indicated by the footnote below the table, the core losses of the old transformers have increased at least 25 per cent, due to ageing of the core iron.

All transformers have a serial number and the manufacturers can, no doubt, advise what serial number changes were made in their equipment. Knowing the serial number of the transformer, it is a simple matter to ascertain its core loss by referring to Table I and locating under which column the transformer was manufactured from the footnotes. Core losses for other transformers may be obtained from similar tables compiled by other manufacturers.

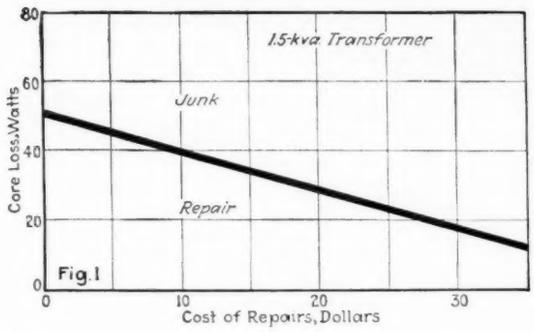
TABLE I—OPERATING CHARACTERISTICS OF GENERAL ELECTRIC TYPE H DISTRIBUTION TRANSFORMERS MANUFACTURED SINCE 1896
FOR OPERATING ON 2,300-VOLT 60-CYCLE CIRCUITS*

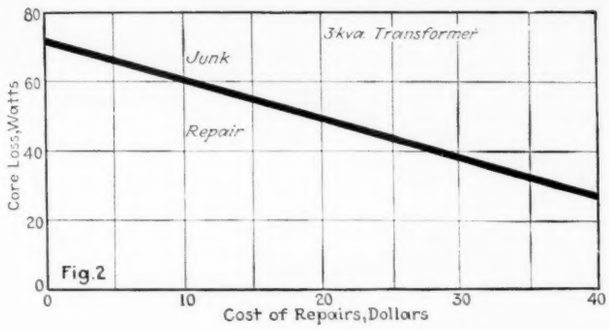
Rating	Losses in Watts									
	Column 1		Column 2		Column 3		Column 4		Column 5	
Kva.	Core	Copper	Core	Copper	Core	Copper	Core	Copper	Core	Copper
0.6	28	16	28	16	24	15				
1	37	27	34	24	31	25				
1.5	43	36	41	38	37	35	22	47	21	47
2	53	48	49	47	43	46				
2.5	55	57	53	51	47	53				
3	58	68	54	69	53	67	32	82	30	82
4	74	90	67	88	62	81				
5	78	106	83	94	70	107	42	108	38	108
7.5	117	156	105	129	98	147	54	151	52	151
10	139	186	135	155	121	175	64	193	62	193
15	184	271	183	227	155	248	88	263	86	263
20	220	327	220	292	180	290				
25	246	392	232	350	205	375	130	415	128	390
30	280	511	271	410	230	428				
37.5	...	...	...	...	...	...	175	570	170	570
40	336	640	322	550	293	565				
50	406	803	372	670	345	675	212	735	212	735

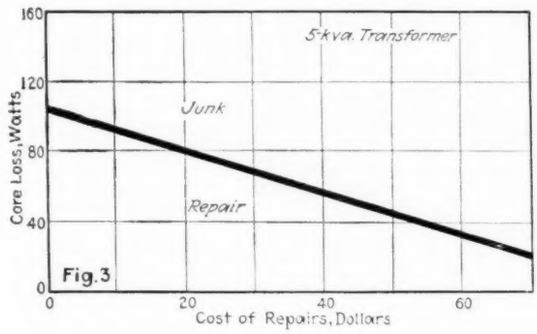
Column 1: Rating 1,040 and 2,080 to 104 and 208, adjusted to 2,300 volts. Designs by form letters *A*, *C*, *E*, *F* and *I*. Furnished during the period 1896 to 1903. Serial Nos. approximately 82,600 to 250,000.
We estimate that, where these transformers are in service at the present time, the core losses are not less than 25 per cent higher than the values shown, due to aging of the core iron.
Column 2: These losses apply to transformers rated 1,040 and 2,080 to 104 and 208, adjusted to 2,300 volts, representing the first designs having non-aging silicon steel cores. They are identified as form *G* transformers, and were furnished during the period 1903 to 1907. Serial Nos. approximately 250,000 to 500,000.
Column 3: These losses apply to transformers rated 2,200 to 110 and 220, adjusted to 2,300 volts. The designs are identified as form *H*, and were furnished during the period 1907 to 1910. Serial Nos. approximately 500,000 to 750,000.
Column 4: These losses apply to transformers rated 2,200 to 110 and 220; 2,300 to 115 and 230; and 2,400 to 120 and 240. The designs are identified as forms *K* and *N* and were furnished during the period 1910 to October, 1922. Serial Nos. approximately 750,000 to 2,730,000.
Column 5: Present outstanding losses applying to forms *K* and *N*, furnished subsequent to October, 1922, having serial Nos. 2,730,000 and higher.
(Reprinted from General Electric Print. C-73280)

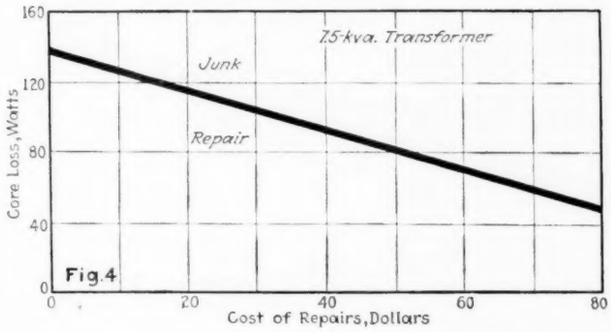
In addition to knowing transformer core loss the following items must be considered when making the economic study:

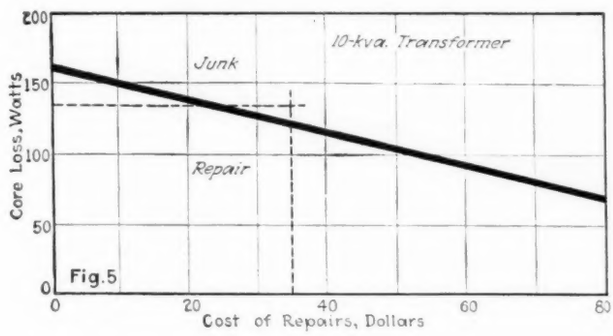
1. Present transformer cost.
(This will vary in different sections of the country

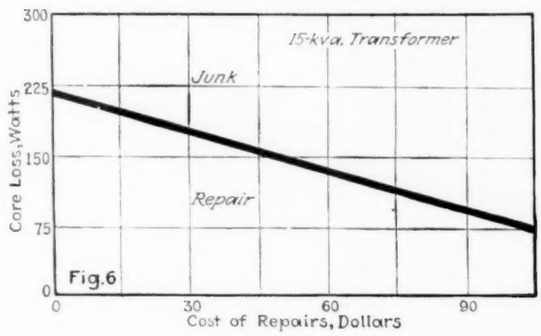


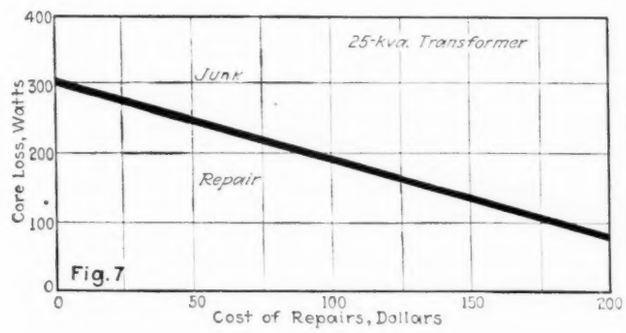


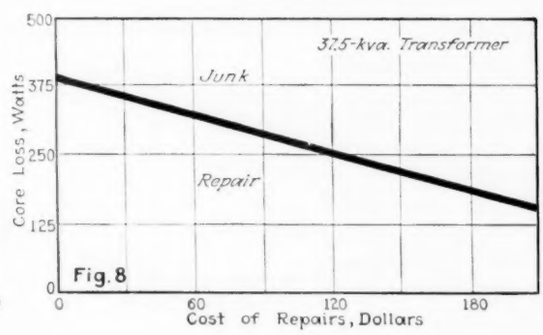


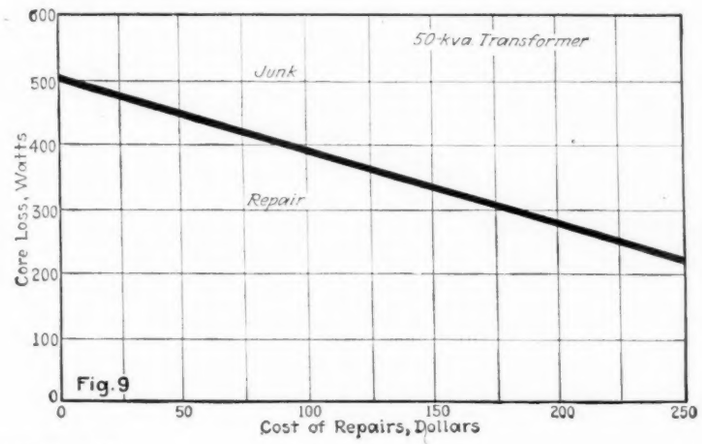












Figs. 1 to 9—Expenditures that can be made for repairs on 2,300-volt 60-cycle transformers, manufactured since 1896, before it will be more economical to junk them. If the intersection of the core-loss value and the cost of repairs falls below the curve, repairing the transformer is more economical than installing a new transformer. If the intersection falls above the curve then the transformer should be junked

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and the cost figures in Table II are only approximate.)

2. Junk value of the old transformer.

(Taken as $1 per kva. Some may consider this value low but it is a safe figure to use.)

3. Annual fixed overhead cost.

(Taken at 15 per cent of difference in cost between a new transformer and the junk value of an old one. The value 15 per cent may vary in some sections.)

4. Operating costs.

(For old and new transformers, derived from capitalizing the core loss at 2c. per kw.-hr. for one year.)

5. Allowable cost for repairs.

Once these figures have been compiled as illustrated in Table II, the results, as indicated for a 50-kva. transformer, may be computed as shown by the following formula and typical problem:

In this problem the cost of the new 50-kva. transformer is taken at $395 as obtained in the first column of Table II. At one dollar per kilovolt-ampere the old 50-kva. transformer would have a salvage value of $50. The core losses for the new transformers are taken at 212 watts, as given in column 5, Table I. The core losses for the old transformers are taken at 350 watts and correspond approximately to the value given in column 3 of Table I, as it is assumed that the old transformer was designed some time between 1907 and 1910. If the transformers come into the class in column 1 of the table, the core losses should be increased at least 25 per cent over the values given in the column. This increase in core losses, as stated in the footnote below the table, is caused by ageing of the iron.

A = Annual overhead cost = (new — junk value of old) × (15 per cent ÷ 100) = ($395.00 — $50.00) × 0.15 = $51.75

B = Operating cost of new transformer = $\frac{\text{core loss}}{1{,}000} \times$ hr. per yr. × $0.02 = $\frac{212}{1{,}000} \times 8{,}760 \times \$0.02 =$ $37.10

T = Total yearly cost of operating transformer = $88.85

C = Operating cost of old transformer = $\frac{\text{core loss}}{1{,}000} \times$ hr. per yr. = $0.02 = $\frac{350}{1{,}000} \times 8{,}760 \times \$0.02 =$ $61.50

D = $(A + B) - C$ = annual cost allowable for repairs = $27.35

Figuring the transformer should be good for 5 years additional service, then ($D \times 5$) equals allowable amount to be expended for repairs equals $27.35 × 5 = $136.75.

These formulas may be employed to calculate three of four points for a curve, the results being tabulated as shown in Table III. Similar calculations may be made for the different sizes of transformers in use and the results tabulated in a table similar to Table III.

Core-loss figures found in the headings of Table III are selected as a convenient scale for calculation and plotting and are within the range of core loss for a transformer manufactured since 1896 to the present day. They do not refer to any particular transformer, but are merely selected in order to obtain points for the curve.

From these data the curves in Figs. 1, 2, 3, 4, 5, 6, 7, 8 and 9 are plotted. A convenient scale for the ordinate and abscissa is laid out on graph paper, the four points plotted, and a line drawn through these points forms a curve. These curves are most useful, and their application simplifies determining whether a transformer should be repaired or junked.

For example, a 10-kva. transformer has been received in the repair shop with broken primary bushings, cracked terminal board and needing new secondary leads. It is estimated it will cost $35 to repair and return the transformer to first-class operating condition. The serial number is referred to and found to be 282,732. Referring to Table I, it is found that a transformer with this serial number was manufactured between 1903 and 1907, the core loss for which is found in column 2 opposite 10 kva., and is 135 watts.

TABLE II—TRANSFORMER COSTS

Size Kva.	Approx. Transf. Cost	Junk Value at $1.00 per Kva.	Less Salvage Value	*A* Dollars	*B* Dollars	*T* Dollars
1.5	$36.50	$1.50	$35.00	5.25	3.68	8.93
3	51.00	3.00	48.00	7.20	5.27	12.47
5	78.00	5.00	73.00	10.90	6.66	17.56
7.5	102.00	7.50	94.50	14.15	9.13	23.28
10	124.00	10.00	114.00	17.10	10.90	28.00
15	165.00	15.00	150.00	22.50	15.10	37.60
25	240.00	25.00	215.00	32.15	22.50	65.65
37.5	320.00	37.50	282.50	40.75	29.90	70.65
50	395.00	50.00	345.00	**51.75**	37.10	88.85

TABLE III—OPERATING COSTS FOR 50-KVA. TRANSFORMERS

Core loss of old transformer*	200	275	350	425
T, Yearly cost of operating transformer	88.85	88.85	88.85	88.85
C, Operating cost for old transformer	35.00	48.30	61.50	75.50
D, Annual cost allowable for repairs	53.85	40.55	27.35	14.35
Allowable amount to be expended for repairs. *D*x5	269.25	202.75	136.75	71.75

* Not actual core loss as given in Table I, but figures selected within the range of core loss for a 50-kva. transformer built since 1896 so that points for a curve may be computed.

Referring to Fig. 5, a core loss of 135 watts is located on the ordinate and a repair cost of $35 on the abscissa. Horizontal and vertical lines are drawn from these two points until they intersect, as indicated by the dotted lines. It is found their intersection lies above the curve, which indicates that the transformer should be junked and not repaired. Once the curves have been plotted, it is a simple matter to determine whether a transformer should be repaired or junked and thus save money.

If it is found that a transformer needs repairs, for which there are no repair-cost curves available, the curve for the nearest size transformer may be used and only a small error result.

All nine curves have been published, as it may be found that the cost and other data used for computations will approximately apply to others' problems, in which case the curves may be applied directly with but a small error and thus avert the plotting of new curves. Although the curves have been worked out for one manufacturer's product, they may be applied to any transformers produced within the periods represented, with fairly close results. These curves do not represent an absolutely correct solution of the problem, but give results close enough for practical purposes, and are being applied by one large company to determine when to repair or replace its damaged transformers.

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How Would You Do It?

By M. E. Wagner

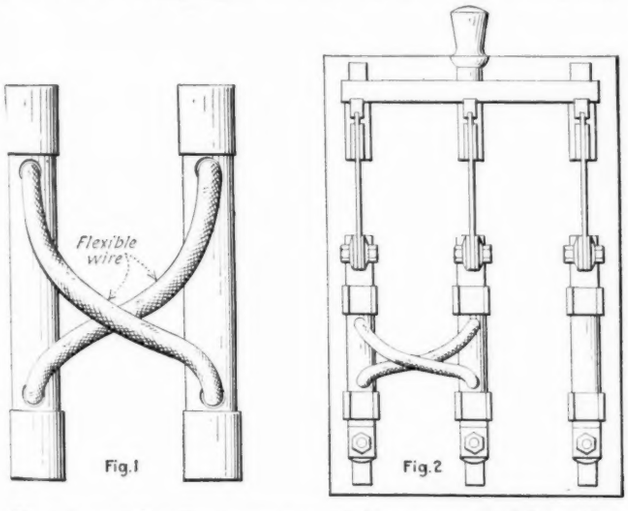
IN THE plant that I am operating there are two 250-kva., 2,300-volt, three-phase generators. One of the machines is driven by a steam engine and the other by a Diesel engine, and each generator has its own direct-connected exciter.

Although it has not occurred, I have been considering what would be the best method of starting the Diesel engine unit, provided the starting air pressure were not available for any reason. It seems to me that it should be possible to start the unit by using the generator as a synchronous motor and taking power from the steam-engine unit. It may be that some of *Power's* readers have had experience with such a combination of machines and can answer the question.

An Emergency Method for Reversing Polyphase Motors

By David Williams

A COMMON method of reversing a motor is through the medium of a two-pole double-throw switch. Such a means serves the purpose very nicely where there is frequent reversing of the motor. Not long ago I ran across what seemed to be a handy kink for emergency



Figs. 1 and 2—Cross-connected fuse cases and how they were used in the motor switch

reversing. A group of motors were driving machines, and once in a while the product would jam in such a way that the machines would have to be reversed to get operation started again.

The motors were 220-volt three-phase and protected by fuses. At first, whenever it was necessary to reverse one of the machines, the electrician interchanged two of the motor leads at the switch. This took considerable time and to say the least was not a desirable way of doing the job, and it always required the electrician to do the work. Instead of putting a reverse switch in on each of the motors, the ends of two empty fuse cases were cross-connected with flexible wire as indicated in Fig. 1. These were left with the machine operators, and whenever the occasion arose for reversing a machine, the operator opened the motor switch, removed two of the fuses and inserted the cross-connected fuse cases as shown in Fig. 2.

This device, however, is not a reverse switch and cannot be considered as such, but is a handy method that can be used where it is necessary to reverse a three- or a two-phase motor at infrequent intervals. During the reverse period the motor is protected by only one fuse, but this is not a serious objection, as operation under this condition is only for a few minutes at any one time.

Seasoning a New Commutator

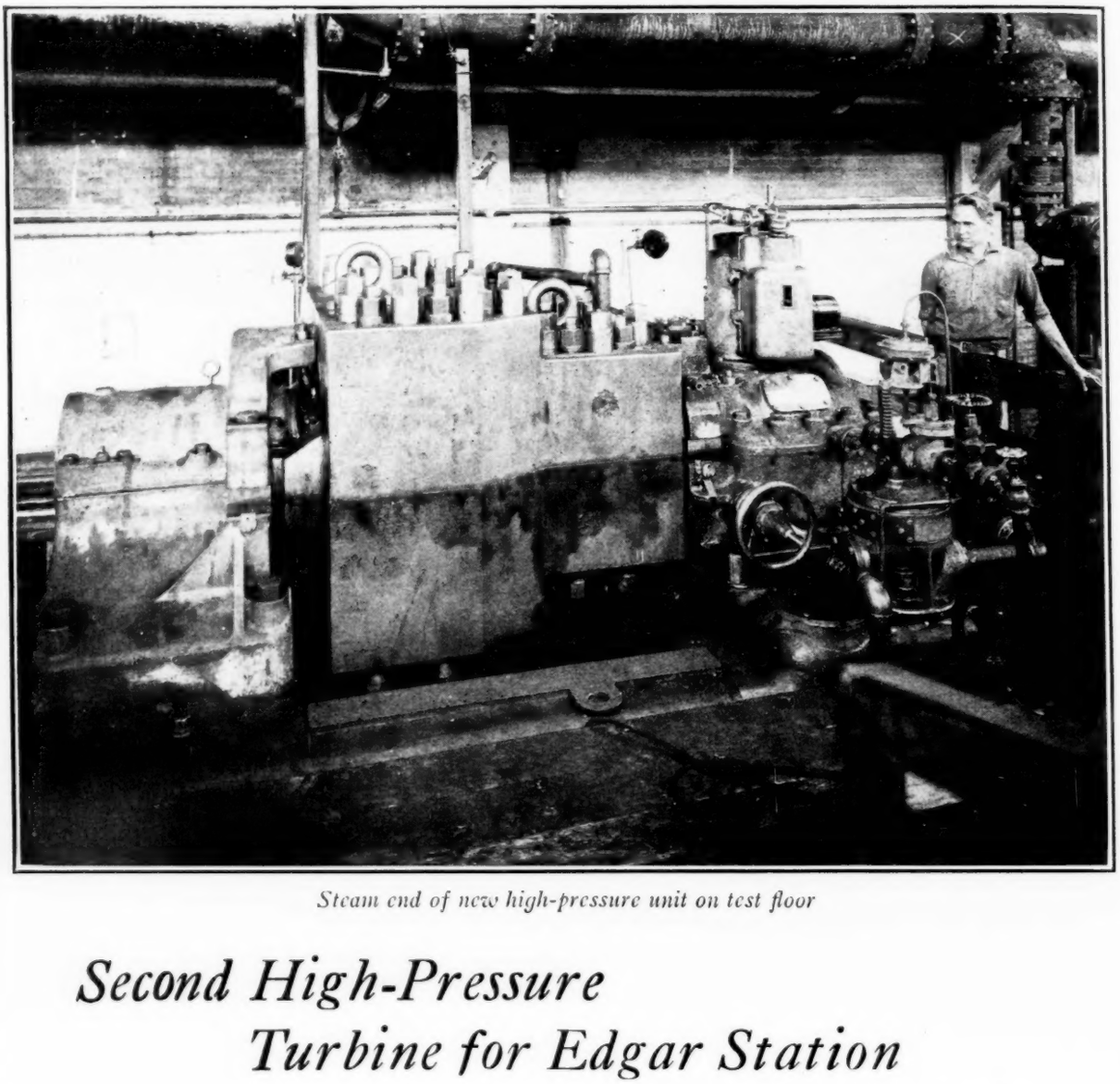
By R. C. Martin

I WAS much interested in reading the practical suggestions on the care of commutators, by E. J. Sacco, in Sept. 20 issue. There is one feature of commutator maintenance that Mr. Sacco did not touch upon and that may be of vital importance in the satisfactory operation of the machine. For the first few months that a motor or generator is in service, the commutator is seasoning and should be watched to see that the bars do not become loose or that the binding material is not forced out of the mica, causing poor contact of the brushes. The latter is likely to happen if the mica is flush. In some cases the mica has been known to give sufficiently to cause it to rise above the commutator surface and produce serious sparking at the brushes.

In the shop, after the commutator is assembled, it is heated in an endeavor to pull it together to a permanent set. With the larger machines they are operated to heat the commutator while running and duplicate service conditions. Notwithstanding these precautions commutators have been known to work loose after the machine has been put into service. Therefore about once per month for six months after the machine goes into regular operation, the commutator bolts should be tested to see if they are loose, just after stopping the machine.

Care should be taken not to set the bolt up too tightly, since there is danger of distorting the commutator. When tightening the bolts if the V-rings are in one piece, take up a little on each bolt, one after the other around the commutator, and then repeat until the tightening process is completed. Where the flanges are made in sections, the center bolt in each section should be tightened a little first, then the end bolts in these sections and following this the remaining bolts. This system is repeated until all bolts have been tightened.

Any roughness that may develop on the surface of the commutator may be cleared up with a hand stone. Before applying a stone to the commutator, it should first be sandpapered to clean off the glaze and any oil there may be on the surface. This will prevent a glaze forming on the stone and very materially improves the grinding action.



Steam end of new high-pressure unit on test floor

Second High-Pressure Turbine for Edgar Station Near Completion

THE success of the first high-pressure installation at the Edgar Station, consisting of a 2,500-kw. turbine-generator, supplied with steam at 1,200 lb. by a single high-pressure boiler and exhausting into the station system at 375 lb., led the Edison Electric Illuminating Company of Boston to order a second, but larger, unit.

This machine is here shown assembled on the test floor of the General Electric Company at Schenectady. It is rated at 10,000 kw. (12,500 kva. and 80 per cent power factor) and will receive steam at 1,200 lb. 700 deg. from two high-pressure boilers, similar in design to the first, but larger, and tested for a maximum of 1,400 lb. operating pressure (for a description of these tests see *Power*, Aug. 30, 1927). Exhaust will be at 375 lb. gage to a 65,000-kw. turbine.

Unlike the first unit, the turbine casing is not a casting, but a forging in two halves held together by twenty-four through bolts. The shaft and wheels are machined from a steel forging. Dimensions of the machine are: Length, 35 ft.; width, 10 ft. 2 in.; height, 6 ft. 9 in.

Combination of steam and water-seal packings are employed at both the high- and the low-pressure ends of the shaft, and a standard G.E. governor of the oil-actuated type will be used to maintain the normal speed of 3,600 r.p.m.

Pounds of Steam per Kilowatt-Hour—Not per Indicated Horsepower-Hour

Why It Is Impracticable To Determine the Latter Accurately and Its Uselessness as a Standard Measure of Engine Performance

By F. E. TROXEL*

IS THERE any good, logical reason why the user of an engine-generator unit should be interested in knowing how many pounds of steam his engine alone is using to produce an indicated horsepower-hour rather than the amount of steam that the combined unit is using to produce a kilowatt-hour? It is the over-all efficiency of the combined unit that counts most.

Engine builders apparently are willing to use the kilowatt-hour output as the standard for engine-generator performance, but the greatest hindrance to this seems to rest with the public. It is, therefore, the writer's purpose to set forth briefly some of the advantages and disadvantages of the two standards of comparison with the idea of enlightening the reader on a subject which seems to have been little discussed in the past.

There are still many cases where the prospective purchaser of an engine-generator set incorporates in his specification that the steam-consumption guarantees are to be stated in pounds per indicated horsepower per hour. Many of these cases can be attributed to the fact that some old engine specification has been resurrected and copied time after time without regard to modern progress, and as a result we are still following in the footstep of our grandfathers.

For the indicated horsepower test one must ascertain the following seven items:

1. Total weight of steam condensed.
2. Percentage of moisture in steam.
3. Bore of engine cylinder.
4. Length of engine stroke.
5. Diameter of piston rod.
6. Speed of engine in revolutions per minute.
7. Indicator diagrams and the corresponding mean effective pressures.

For testing on the basis of kilowatt-hour output one needs only three readings:

1. Total weight of steam condensed.
2. Percentage of moisture in steam.
3. Kilowatt output of generator.

In either test items 1 and 2 are the same, and therefore the percentage of error in readings and the calibration of instruments would be the same for the kilowatt basis as for the indicated horsepower basis. For the greater accuracy the various instruments can be calibrated and corrections made accordingly so that the percentage of error in either test may be reduced to the minimum.

Items 3 and 4 (bore and stroke) in the indicated horsepower test are simply matters of measurement and are in most cases taken as stated on the manufacturer's nameplate. For the sake of accuracy, however, it would be best to check these, especially the cylinder bore, as cylinders are sometimes bored oversize and a difference of $\frac{1}{8}$ in. on a 20-in. diameter cylinder makes a difference of 1.25 per cent in the area of the piston. The diameter of the piston rod, item 5, is needed to get the net piston area of the crank end and the indicated horsepower should be calculated for each end separately and added together to obtain the total indicated power of the engine.

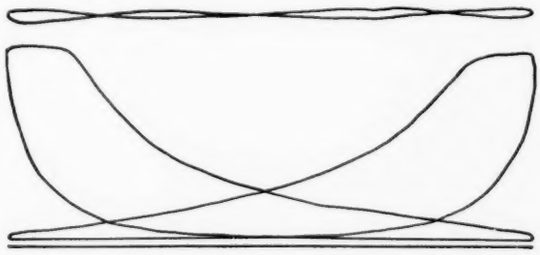


Fig. 1—Typical indicator diagram from a four-valve engine

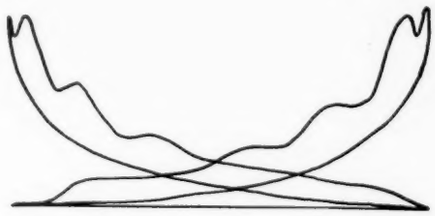


Fig. 2—From a uniflow engine, illustrating difficulty of obtaining a smooth diagram at 450 r.p.m.

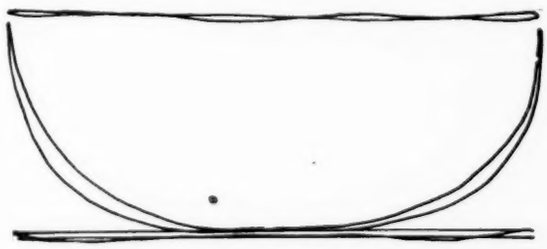


Fig. 3—Friction load diagram from four-valve engine

*Engineer, Ridgeway Works, Elliott Company.

The chances for errors in the three items previously mentioned are comparatively small, but the greatest chance for error is in obtaining the mean effective pressure from the indicator diagrams. The writer recently took five sets of consecutive indicator diagrams from a four-valve engine running on constant load; one of these is reproduced in Fig. 1. These diagrams were carefully traced two different times with the planimeter and the

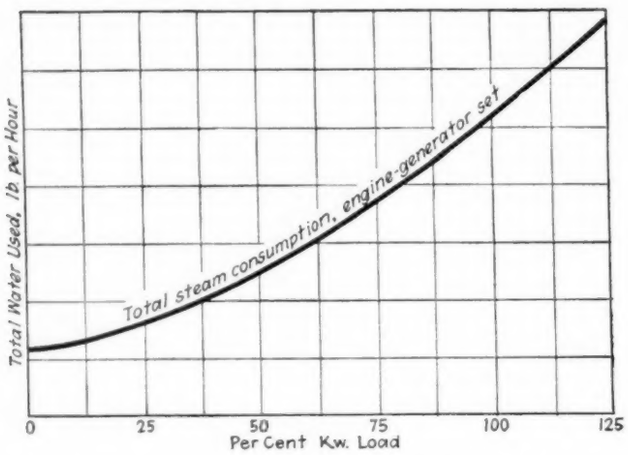


Fig. 4—Total steam consumption plotted against per cent kilowatt load

various readings tabulated. This tabulation showed difference as high as 4 per cent with some of the diagrams and an average difference of 1.93 per cent for the ten readings. The same procedure was carried out by a second party whose difference in readings ran over 5 per cent in one case, although the average differences in his readings were only 1.76 per cent. The greatest difference between the mean effective pressure of any one diagram by the two parties was 5.35 per cent.

Since the error in obtaining the mean effective pressure will easily vary by 2 per cent, steam consumption expressed in pounds per indicated horsepower varies by at least the same amount. To offset this the only chance for error when using the kilowatt-hour as a basis is in the reading of the wattmeter, which can be calibrated with standard instruments and corrections made so that the limit of error will be a small fraction of one per cent.

The ease and simplicity of conducting the over-all steam consumption test is its outstanding feature. Simply divide the weight of condensate per hour (corrected for moisture) by the kilowatt output, and the result is the water rate of the combined unit in pounds per kilowatt-hour.

It is not the intention of the writer to condemn the indicator or the indicator diagram; in fact, it is important in obtaining proper valve settings and other events of the cycle. When conducting an engine test, it is highly important that the indicator diagram be as nearly perfect as is possible even for testing on a kilowatt basis, as the engine will do its best when the events are properly timed and the valves and piston are steamtight.

In the case of a high-speed multi-cylinder engine the problem of obtaining good indicator diagrams with the ordinary indicator is all the more complicated. A diagram taken at 450 r.p.m. from a multi-cylinder uniflow engine is reproduced in Fig. 2. The irregular expansion line might be attributed to vibration in the indicator arm, and yet the compression line is smooth. This diagram is hardly suitable for a steam consumption test on the basis of indicated horsepower. Various types of indicators have been perfected for use on high-speed engines and some seem to have proved satisfactory. It would even be feasible to go to the expense of developing some highly refined mechanism such as the oscillograph for the more accurate study of the engine cycle. The cost of this would, however, be prohibitive for use on ordinary steam consumption tests based on indicated horsepower, but it would be of inestimable value in getting proper adjustments of the engine for a kilowatt-hour test.

For obtaining the friction horsepower of an engine, the friction indicator diagram is practically worthless. Reference to Fig. 3 will show this. In tracing over this narrow and indefinite diagram with the planimeter, the accuracy would be problematical.

The frictional steam consumption can best be studied in connection with the kilowatt output as illustrated in Fig. 4, where the total pounds of water used per hour by the engine is plotted against the percentage of kilowatt load. The point where the curve intersects the zero line is the frictional steam consumption of the combined unit.

In actual test it is practically impossible to segregate the frictional losses and the generator losses. Little is known as to the rate of increase in the frictional

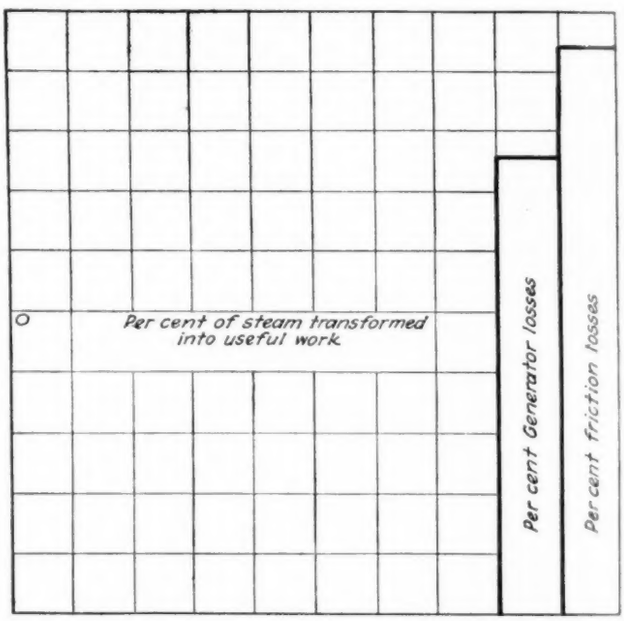


Fig. 5—Useful work, generator losses and friction expressed in percentage of total steam

horsepower of the engine with increase in kilowatt output. Fig. 5 shows diagrammatically the average percentage of useful work obtained from any given quantity of steam, the average generator loss and the average frictional loss. The square is divided into 100 parts so that each small square represents one per cent. Generator efficiencies are based principally on calculations and for the most part are more reliable than the frictional losses in the engine. And yet, why should one try to segregate these losses and use separate engine and

generator efficiencies when one over-all efficiency of this combined unit is the simplest and most dependable method to follow?

In cases where the engine manufacturer uses a generator of another make, it is an easy matter to give his steam consumption guarantees in pounds per kilowatt-hour output on the basis of a generator efficiency of 100 per cent. These values can then be divided by the generator manufacturer's efficiency guarantees at the various load points to obtain the actual water rate in pounds per kilowatt-hour.

The steam turbine presents another phase of the story in favor of the kilowatt basis of steam consumption. The construction of the turbine makes it a physical impossibility to obtain anything like the indicated horsepower of the unit, so there is no other choice than to use the kilowatt output as the comparative standard of performance for turbine-generator units.

In the engineering field today the trend is along the lines of standardization wherever possible, and it is only reasonable to hope that this small side-light on engine-generator performance will warrant consideration and possible adoption.

Power Study Shows Importance of Coal in Power Generation

THE total amount of electricity produced at public utility power plants in 1926 was 73,791,000,000 kw.hr., according to an investigation made by the Geological Survey, Department of the Interior. Of this total power generated, 57.7 per cent was produced from coal, 35.5 per cent from water, 3.1 per cent from oil, 3.13 per cent from gas and 0.4 per cent from wood. The use of fuel oil in generating electricity has declined since 1924, when it reached its maximum. The amount used in 1926 was the least since 1918, and only 57 per cent of that consumed in 1924.

The best fuel rates for these fuels were about as follows: coal, 0.9 lb. per kw.hr.; oil, 450 kw.hr. per bbl.; gas, 13 cu.ft. per kw.-hr. As these are, roughly, one-half the average actual rates, the consumption of fuel by electric public utility plants would be reduced one-half if all produced electricity at the best fuel rates; and the attainment of this degree of efficiency would have conserved 20,000,000 tons of coal in 1926, representing about $75,000,000.

PIPING SHOULD BE PITCHED to drain condensate in the direction that the steam is to flow, that is, from the boiler toward the engine, except for the short distance from the boiler stop valve to the boiler, which should be pitched to drain back to the boiler, so that there will be no condensate held in the connection up to the valve when it is closed. If the main piping is pitched to drain back to the boiler, the condensate will be carried to the engine from time to time as slugs of water are first gathered and held along the pipe, and then suddenly swept along by the steam. The water thus delivered temporarily faster than it can be taken care of at the engine, may result in a wreck. The pitch back to the boiler may be steep enough to obtain flow of the condensate in the direction opposite to the flow of steam, provided the pipe is so large that there is a very low velocity of the steam.

What Do You Know?

The answers are on page 566

SOME of *Power's* readers complain that the "What Do You Know" questions are too easy. Now here are ten tricky questions. You need not be disappointed if you cannot answer all. But your score should be 60 per cent. If the editor's answers seem wrong, do not fail to write.

Ques. 1—Why does the A.S.M.E. Boiler Code law require the chamfering of the tube holes inside and outside?

Ques. 2—Why does the Code prohibit longitudinal joints over 12 ft. long? Does the same law apply to water-tube boilers?

Ques. 3—Will a saturated mixture of air and gasoline vapor at a temperature of, say, 86 deg. F. explode if a spark or light is introduced?

Ques. 4—In a four-stroke-cycle single-acting internal-combustion engine at what approximate point in the suction stroke is the pressure on the wristpin bearing reversed?

Ques. 5—A compound air compressor delivers air at 132.3 lb. gage, giving a pressure ratio of 10. The intermediate pressure is 31.8 lb. gage, or 46.6 lb. abs. Suppose the discharge pressure is raised to 147 lb. gage, will the intermediate pressure change? If so, in how many strokes?

Ques. 6—What would you use to stop ice-can corrosion?

Ques. 7—Suppose you had a plant containing a 200-kw. steam-engine-driven alternator and a similar Diesel-driven unit. Assuming that you lost the starting air for the Diesel, how would you get the Diesel started?

Ques. 8—In a pumping plant where a triplex pump would not lift water over 10 ft., while the actual suction lift was 14 ft., would it help this pump to deliver water if a second pump, capable of raising water 16 ft., were installed with the suction lines connected?

Ques. 9—Why, in a single-valve high-speed engine, does the compressor run high at light loads?

Ques. 10—How would you straighten the spindle of a 1,500-kw. steam turbine that has bent in service and it was impossible to send it to the factory?

EDITORIALS

F. R. LOW, *Editor*

Condenser Vibration

A CONDENSING turbine of medium size was purchased and installed in the plant of a well-known manufacturer. The contract covered certain water-rate guarantees which subsequent service tests failed to meet. Inasmuch as the turbine builder had turned out many similar machines and there were no unknown factors concerned in the design, it was improbable that there had been any guesswork.

The mystery deepened, however, when it was discovered that at times the guaranteed water rate was met, while at other times it was greatly exceeded. Further investigation revealed that this discrepancy was not the fault of the turbine, but was due to condenser leakage caused by tube vibrations which loosened them at the tube sheets. The difficulty was met by inserting additional spacer plates.

Turbine vibration, it will be recalled, presented a serious problem a few years ago. It was only through extensive and costly research on the part of certain builders that the causes were discovered, and it thus became possible to anticipate and avoid harmful vibration through changes in design.

May not a somewhat similar problem exist with regard to condensers? Is the tube vibration related to turbine vibration, to impulses in the exhaust steam at certain loads, or does some other cyclic relation obtain?

The phenomenon may have been encountered before by condenser designers, but has it ever been made the subject of thorough investigation? It is something little understood by consulting engineers and operators, and dissemination of existing information would be welcomed.

Oil-Engine Rating

IT IS difficult for any group of engineers interested in oil engines to break up before the battle of engine rating is refought. Some throw down the gage in favor of high brake mean effective pressures, others announce they will battle for moderate ratings, and a few incline to favor still lower pressures.

The advocates of the several pressure ranges overlook the fact that the engine design is the limiting factor, and mean effective pressures possible in one engine are unobtainable in another. If, by reason of scavenging arrangements, a particular engine cannot show better than forty-five pounds brake mean effective pressure, the builder must necessarily set a limit on the ratings given. On the other hand, an engine may be able to develop twice this pressure, owing solely to design. It is not surprising, then, that a difference of opinion exists.

One reason that a higher mean pressure is used by some manufacturers than by others is that the first class take into consideration the service to which the engine is to be put. If the work is occasional or if full load is to be carried for brief periods only, there is no reason why the engine should not be rated at a higher pressure than would be advisable in the event the engine was to carry a heavy load continuously.

In purchasing an engine, due consideration should be given to the engine design as influencing the rating. Is the rating given, the highest the engine can develop safely and economically? Another question needing answer is: What have been the results obtained by other engines of the same make?

In addition a purchaser should see to it that the engine's fuel-consumption curve is such that the rated mean effective pressure corresponds to a low point on this curve, though not necessarily the lowest.

Silent Inefficiency

FACTORS that contribute to inefficiency in a plant may be divided into two classes, those that call attention to their presence by some disagreeable action and those that are silent. Steam blowing out of a leaky gland, a leak in a water or oil line are likely to receive attention on account of the displeasing condition they create, while other leaks that are not visible may be entirely ignored.

Unfortunately, by far the most important causes of inefficiency are silent. Uninsulated steam lines and other hot surfaces may cause large losses, but they may be entirely ignored, while a minor steam leak may receive immediate attention. The stack-gas temperatures may be excessive without anyone giving the matter consideration, whereas if the safety valve popped on a boiler, adjustments would be made at once to prevent the blowing of steam to the atmosphere and its unpleasant action.

In a water-power plant a small leak in a pipe line may be corrected at the first opportunity, when fifty times as much water may leak through the waterwheel gates and

be entirely ignored. Trash may pile up on the bottom of the racks and cause a considerable loss of head without anyone taking the trouble to find out the condition, when a leak on a pump would be fixed the first time the pump was out of service.

Losses due to using too small cables, the use of too large motor or to motor-control equipment improperly applied, low power factor, improper wall surfaces where artificial illumination is used, are all forms of silent inefficiency. Although they may not make an unpleasant noise or create a disagreeable condition in the plant, they do cause greater losses than many of the things that do. It is pleasant to see shining brass and every piece of metal polished and to have all glands and joints tight in the plant, but this is not an absolute indication of efficient operation.

The Design of Mills To Pulverize Coal

MANY mills have been placed on the market to prepare pulverized coal. Inventors have put forward claims of certain advantages for each of these, and many have given excellent performances in service. There does not appear to be a great difference in the power required, under test conditions, to pulverize the coal by many of these mills. Yet undoubtedly gains might be made in power reduction if the effect of the pressure of the rotating on the stationary elements were studied for each coal and for various sizes of the same coal. It is reasonable to expect that all coals do not require the same grinding pressure and also that this pressure may need to be varied for different sizes of coal. Furthermore, the average dryness of the coal undoubtedly affects grinding properties. Standard mill speeds for all coals, therefore, may not be desirable from an efficiency viewpoint.

Users of powdered-coal mills will ask for at least three characteristics—continuity of operation, sustained efficiency and ease of maintenance. The reliability of the mill must be such that it can operate for long periods without shutdown for oiling, greasing or other needs.

Regarding sustained efficiency, wear in certain mills is of such a nature that the fineness of the coal decreases and this lowers furnace efficiency. It should be possible to redesign such mills and to make such disposition of the metal that extensive wear might take place before this would have any appreciable effect on the degree of fineness of the final product.

Mills may be designed in which the working parts are readily accessible for inspection and repairs. Some designs that have been proposed, have not been desirable in this respect. Modifications may be made in existing designs that will greatly improve this feature.

Finally, mills should be compact and as quiet as possible for the service required. Some designs are wasteful of boiler-room space and are noisy.

Don't Forget the Spare Equipment

IN POWER PLANTS reserve capacity is generally provided so that if one machine has to be taken out of use for inspection and repairs, the service supplied by the station will not be interrupted. This spare capacity generally forms part of the active equipment of the plant and does a regular period of service with the other machines. As a result all equipment is given equal attention and kept in good operating condition. If faults develop, they are detected in the routine inspection and maintenance and are repaired.

Spare units are also provided in power transforming and utilizing equipment, but under these conditions they are not so likely to be given the attention that spare units in a generating station receive. A bank of transformers may be in service for years without its being necessary to use the spare. This continuous operation without trouble is likely to create a false sense of security, and the spare unit may be practically forgotten. Then the emergency arises and no one knows if the spare is in condition to go into service or exactly how to go about getting it into operation with the least delay.

No plant is maintained in its best condition if the spare equipment is neglected, as this is the last line of defense against long shutdowns and should be held ready for immediate use. The oil in a spare transformer should be tested at regular intervals, the same as in those in use. The conditions of the insulation and other parts should receive the same careful attention as those that are in daily service. At an opportune time the spare should be put into service, so that those who have to do the work may be sure they know how.

Where spare motors are available in a plant, they will be better if used to replace other machines and allowing these to be taken out of service for a complete overhauling, than if allowed to remain without attention. One of the surest ways of insuring that equipment will receive attention is to use it, and the spare equipment is no exception.

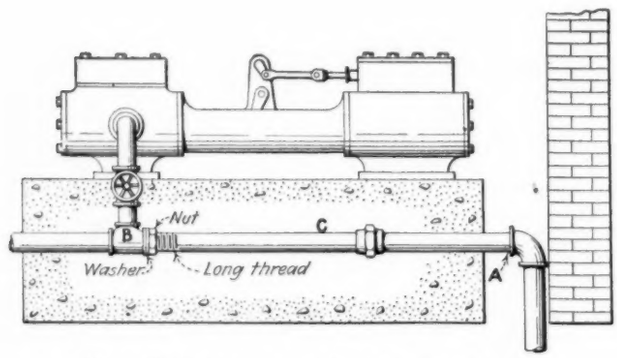
October 25th
issue
Will Announce the
Power Prize Winners
This issue will also contain the three articles that won the prizes of $500, $250 and $100

IDEAS *from* PRACTICAL MEN

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Correct Location of Machinery Facilitates Maintenance and Repair

FREQUENTLY, cases are found where a repair to a particular machine or connecting piping is difficult owing to the machine's being installed too close to a wall or other equipment. In one instance a duplex pump



How the pipe was repaired in limited space

used for boiler feeding was installed with the elbow of the suction pipe against the side wall of the building. Also, the end of the steam cylinder was so close to the wall that there was barely enough room to remove the head or piston.

However, the real trouble came when the suction pipe developed a bad leak at the point *A*. The pipe extended from the tee *B* to an injector. This made it difficult to replace the defective pipe without tearing down considerable piping beyond the tee *B*. If it had not been for the extension pipe, it would have been an easy matter to swing the pipe at an angle and insert the new piece after removing the defective length. The repair was accomplished as follows:

The old piece of pipe was cut with a hacksaw at a point about 3 in. from the elbow *A*, so as to give room for a Stillson wrench to remove the piece from the elbow. A 3-in. piece was also cut from the other pipe to permit unscrewing the two pieces from the fittings. Then a new length was threaded and fitted with one side of a union ready for screwing into the elbow *A*.

The other section of pipe was measured and cut to the proper length, but one end was threaded for a distance of about 2 in. This was fitted with a locknut and washer, then screwed as far as it would go into the tee *B*. This gave room enough to screw the new section of the pipe into the elbow. The long threaded pipe, with the other half of the union, was then backed out of the tee *B* until the union came together.

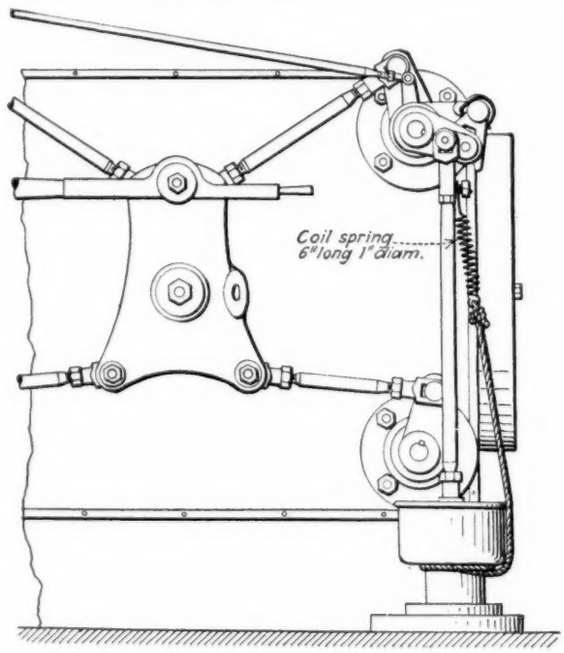
The joint at the tee was made tight by using some stem packing or wicking, after it had been soaked in graphite and cylinder oil. This wicking was placed between the washer and the end of the tee *B* and the locknut tightened against it. H. J. MULLINS.

Birmingham, Ala.

How the Engine Was Kept Running While Waiting for Repairs

AN ENGINEER in a neighboring plant had trouble with the head-end inlet valve sticking badly on his Corliss engine. The valve was worn and the dashpot rings were in bad shape. New parts had been ordered, but the engine had to be kept running until they arrived.

The engineer obtained a stiff coil spring, about 6 in. long, from the shop storekeeper and connected it to the



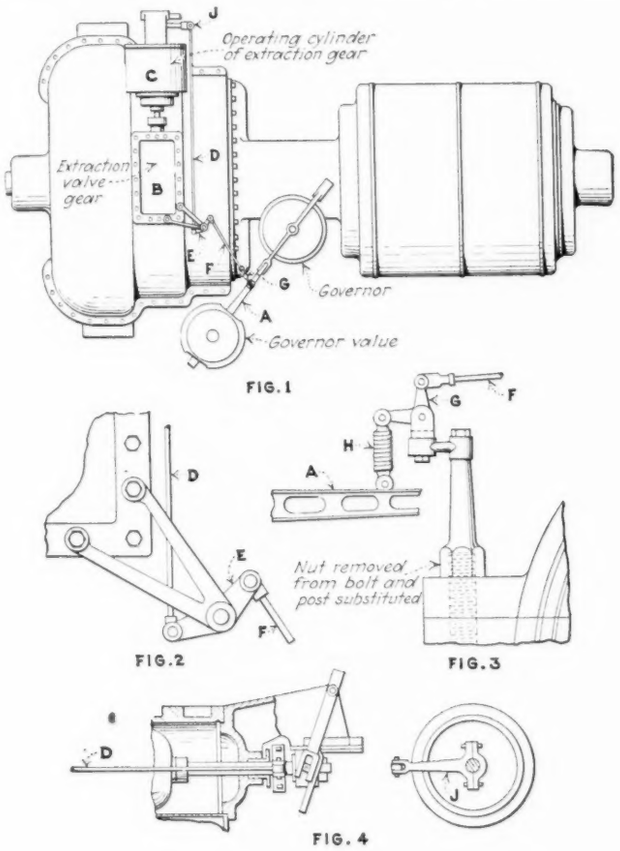
Coil spring used temporarily to close steam valve

upper end of the dashpot rod by hooking it over a setscrew on the side of the rod end. A short piece of rope with a couple of turns around the under side of the dashpot and through the loop on the lower end of the spring completed the connection. The tension on the spring was adjusted with the engine running until the valve operated satisfactorily. With this simple device the engine was kept running for more than a week.

Syracuse, N. Y. H. L. WHEELER.

How the Speed Regulation of an Extraction-Type Turbine Was Improved

STEAM engines and turbines have one thing in common—a change in load means a change in speed. Also, a decrease or increase in the back pressure on either a turbine or engine increases or decreases the speed to some extent. In other words, no governor can anticipate a change of load, so the speed must fluctuate to a lesser or greater degree. In the extraction-type turbine this change in speed is more or less marked if the demand for steam is irregular.



Figs. 1 to 4—Assembly and details of compensator as applied to extraction-type turbine

To offset the fluctuation in speed caused by the operation of the extraction gear, one engineer has designed and built a so-called compensator. The general arrangement of the unit and assembly of the compensator is shown in Fig. 1 and the details of the various parts in Figs. 2, 3 and 4. The purpose of the compensator is to increase or decrease the tension on the auxiliary governor arm *A* in direct relation to the opening and closing of the extraction valve *B* by the operating cylinder *C*. From a study of the drawing the operation of the compensator will be readily understood. The motion from the piston rod of the operating cylinder *C* is transferred to the governor lever through a series of links, bell cranks and spring, *D*, *E*, *F*, *G* and *H*, respectively, as indicated in the assembly and detailed sketches. One end of the link *D* is attached to the piston rod of the operating cylinder by means of the clamp arm *J* and the other to the bell crank *E*, which is supported by a bracket from one corner of the extraction valve gear cover. The bell crank *G* changes the horizontal motion imparted by the link *F* to a vertical motion, which in turn increases or decreases the tension on the governor arm through the spring *H*. The method of supporting the bellcrank *G* is clearly shown in Fig. 3.

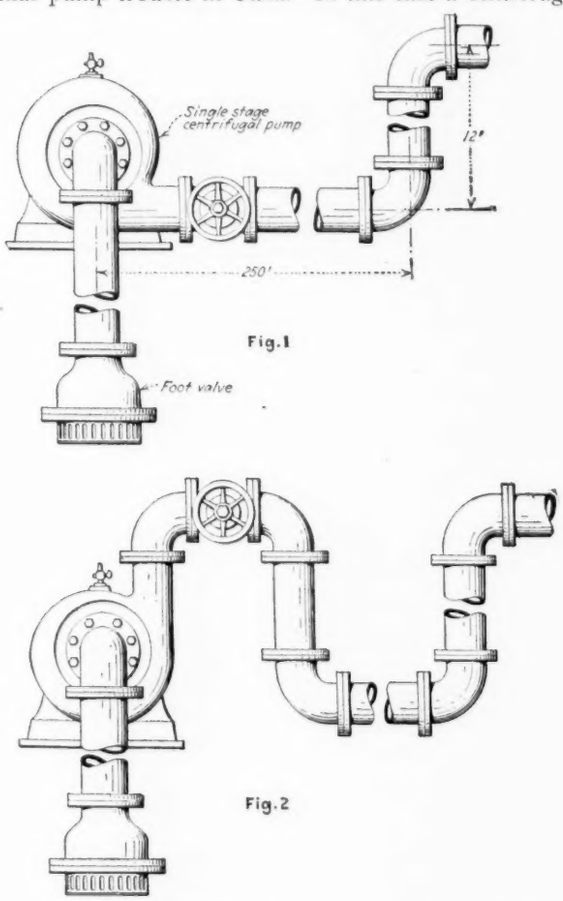
C. W. PETERS.

New York City.

Centrifugal Pump Troubles

A SIX-INCH centrifugal pump was installed with the suction and discharge arranged as in Fig. 1, to pump waste water from a factory sump. On starting up the pump after it had been primed, it would discharge water for about half a minute and then fail. The pump casing was then turned and piped as in Fig. 2, and there was no further trouble.

Having had this experience, I was able to correct a similar pump trouble in Cuba. In this case a centrifugal pump had been installed on the bank of a creek to furnish water to a sugar mill about a quarter of a mile away. There was a gradual rise of about 10 ft. from the pump to the mill and a further 10-ft. rise to the top of a storage tank. The discharge was formerly arranged as Fig. 1, but was later changed as shown in Fig. 2. This eliminated the trouble, which was evidently due to air accumulating in the upper part of the pump casing.



Original and improved arrangement of pump discharge line

Long Beach, Calif. E. J. JORDAN.

COMMENTS *from* READERS

Correcting Faults in the Heating System Returns

REFERRING to the article in the Sept. 13 issue, "Correcting Faults in the Heating System Returns," the author, in referring to heater-blower units says: "Disconnect the coil farthest from the cold-air inlet from the high-pressure steam . . ."

A much greater improvement in results would have been obtained if the coil adjacent to the cold air inlet had been used. Assuming an air-inlet temperature of 70 deg., with outlet temperature of 180 deg. with a mean temperature of 258.5 of the steam in the flash coil, the heat head, with the last coil being used, would be approximately 78 deg., while if the first coil had been used, the heat head would have been approximately 188 degrees.

It is apparent that if the coil adjacent to the air inlet were used, there would be a far greater heat transfer obtained with a possible decided lowering of condensate temperature. This follows the counterflow principle, which is now the standard practice in all heat exchange equipment.

J. G. BENTLY,
Chicago, Ill. Fuel & Service Engineer,
O'Gara Coal Co.

* * * *

Treating Evaporator Feed

I HAVE been particularly impressed with the editorial under the caption of "Clean Evaporators," appearing in the Sept. 13 issue, and am sure that there is a good field for development in this line.

The Engineering Experiment Station at Annapolis has done some work along these lines to reduce scale in marine evaporators where salt water is being used. It has been found that the use of silicate of soda will have considerable effect in reducing the scale deposit. However, it has also been found that when too much of this is used priming will result. This method of reducing scale is being used on numerous vessels in the Naval Service with satisfactory results, although the formation of scale is not actually prevented thereby.

In the case of shore power plants the water evaporated is often quite different from sea water, and the salts contained and the nature of the scale may vary. I have no doubt that some of the boiler compounds would have a material effect in preventing the deposit of hard scale, but I am afraid they would meet the priming problem since, in order to be effective, the alkalinity would be raised and priming is likely to result.

There is no doubt in my mind that, if the matter is properly gone into and a particular compound suitable for the water used determined, this method of keeping down the scale deposit in evaporators would be worth while. However, another point to this problem is whether the additional trouble and expense of adding the compound would compensate for the mechanical work required in periodically removing the scale. If some of the boiler compound manufacturers and power plants would investigate this, fairly definite information might be secured as to just how far it is advisable to apply water treatment on evaporators. Perhaps the A.S.M.E. Committee on Boiler Water Treatment might take up this matter for investigation. Also, if actual results secured in some plants are available, it would be extremely interesting to have someone prepare this information for publication.

H. C. DINGER,
Annapolis, Md. Captain, U. S. N.

* * * *

The Torpedo's Power Plant

HAVING been a rather careful reader of *Power* for some time, I have found among other items, much of interest in your column, "What Do You Know?"

As a former member of the Regular Navy with several years' torpedo experience, I can come very near to calling each piece of a torpedo by its first name, and I regret to say that your answer to question 10 in the Sept. 20 issue is misleading. Our present torpedoes are, or have been known as, steam torpedoes to distinguish them from the old hot-air type. But actually, they do not operate by steam and are nearer to a gas turbine than anything else.

The only oil used is for lubrication, and they do not burn it as a fuel as stated.

These devices are among the most complicated and also most interesting pieces of mechanism in existence, and detailed study of them would be of interest to many.

They are about the only mechanisms which, having been started, perform their whole function without human guidance.

This involves their finding and keeping the required depth and speed, taking and holding the set course (not necessarily the direction in which they are fired) and of course exploding when they strike the target.

It is possible to get hits consistently at distances almost as great as it is possible to see the target.

Philadelphia, Pa. E. A. CRENSHAW, JR.

[The torpedo's power plant was described in *Power*, Sept. 9, 1924. In the "What Do You Know" answer the statement was made that oil was used as the fuel, although actually alcohol is the fuel employed. The word "oil" was used to imply that a liquid fuel was used, even though alcohol is a hydroxite and oil a hydrocarbon. The description given of the plant accurately covered the general principles.—Editor.]

Wet Versus Dry Compression

IN THE issue of *Power* of Sept. 13 W. G. Schmidt discussed some conditions regarding compression and requested that the relative merits of wet and dry compression be discussed, that he may be in a position to remedy a condition that prevails at his plant.

Wet versus dry compression used to be a favorite theme for discussion and investigation by the various refrigerating engineering societies, but after a great deal of time had been given to the subject, it was finally dropped for discussion of other subjects.

As far as over-all efficiency is concerned, there is little difference between wet and dry compression. If the ammonia vapor arrives at the compressor a little moist and not entirely evaporated, that portion of it that did not do work in the expansion coils helps to reduce the power required for compression. So what is lost at one end of the system is gained at the other, provided the vapor does not arrive excessively wet. It should not be assumed that to produce wet compression large amounts of liquid ammonia must enter the compressor cylinder. So long as complete evaporation of the ammonia is not produced before the mixture reaches the cylinder, it is not in the dry saturated state and the compression may be said to be wet if there is any portion of the liquid unevaporated when compression begins.

The vapor may arrive as a fog, or it may arrive as a mist. In either case it is not completely evaporated, and unless it receives heat enough to complete evaporation in passing through the valves or upon meeting the warm cylinder walls, compression will start wet.

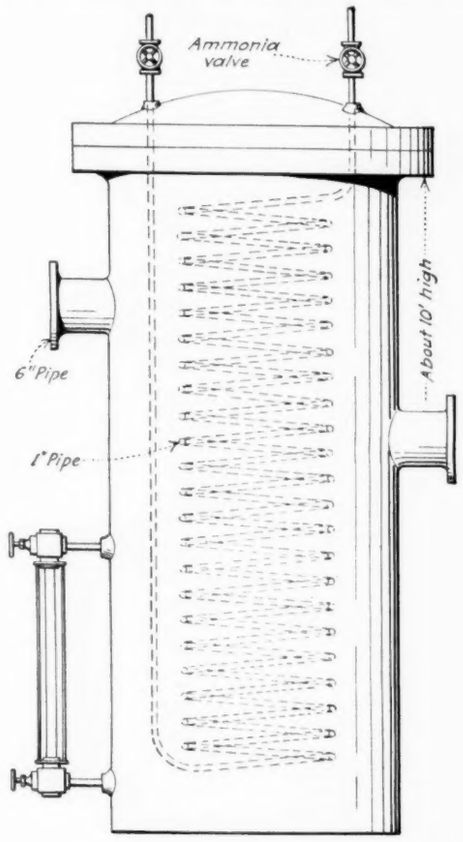
The injection of liquid into the cylinder by a suitable device produces practically the same consumption of power. Briefly summarized, dry compression requires more power but more work is done in the coils; wet compression requires less power but less work is done in the coils.

In large packing houses where there are a great number of expansion valves, many times the expansion man is blamed for a "freeze back," when in reality he is blameless. Consider a large room that has not been opened over Sunday. The coil in this room contains liquid ammonia to some extent. Monday morning the doors of this room are thrown open and the warm outside air allowed to flood the room. Unless the coil is very heavily frosted, there is bound to be a violent evaporation of ammonia within the coil. The vapor from this action, in traveling through cooler parts of the coil, will pick up the liquid and carry it along to the compressor. Coils in hot meat boxes have been known to blow themselves completely dry. Where liquid is coming back to the compressor in this manner, an accumulator in the suction line to the machine would trap off some of this liquid and put it to a useful purpose.

The coil and shell of this accumulator would have to be proportioned for the job in hand. The liquid ammonia going to the expansion valves could be cooled within the coil of this accumulator, care being taken to lead the liquid down the coil and have it leave the accumulator through the straight leg. If this were not done, the advantage of the accumulator would be impaired, for the warm liquid ammonia would pass down the straight leg and be cooled by the liquid ammonia that would be collected in the shell; its ability, therefore, to dry the suction to the machine would be diminished.

Some plants expand liquid ammonia into the shell so that the coil is half submerged. Obviously, this liquid will boil at whatever pressure the suction happens to be, so if the suction pressure carried is 15 lb. gage, the liquid to the expansion coils will leave the accumulator at zero gage. With 70-deg. F. condenser water this will mean a saving of about 75 B.t.u. per pound of ammonia circulated, which is the heat of evaporation necessary to reduce the temperature of the liquid ammonia, after it passes the expansion valve, from 70 deg. F. to the temperature of the coil.

The vapor from this preliminary evaporation amounts to about 13 per cent of the total evaporation in the coils, so that so much more space would be available in the coils. But as the vapor given off in the accumulator from this 75 B.t.u. is the same, the compressor will have



An accumulator will catch the liquid from the coils

to handle the same amount of vapor whether the liquid is cooled or not. Also, the compressor will have to handle the heat from this cooling whether it is done in the accumulator or in the coils. The advantages of the accumulator are that the compressor is made more effective and the coils are made more effective.

A gage glass may be fitted to the accumulator to show the height of the ammonia liquid level within the shell of the cooler. It is better to fit one gage glass within another of larger bore, so that the moisture in the atmosphere will not frost the glass containing liquid ammonia. By raising or lowering the level of ammonia within the shell, more or less of the coil carrying warm liquid will be exposed to the suction vapor. By this means the dryness of the suction may be regulated.

New York City. F. R. MACNEIL.

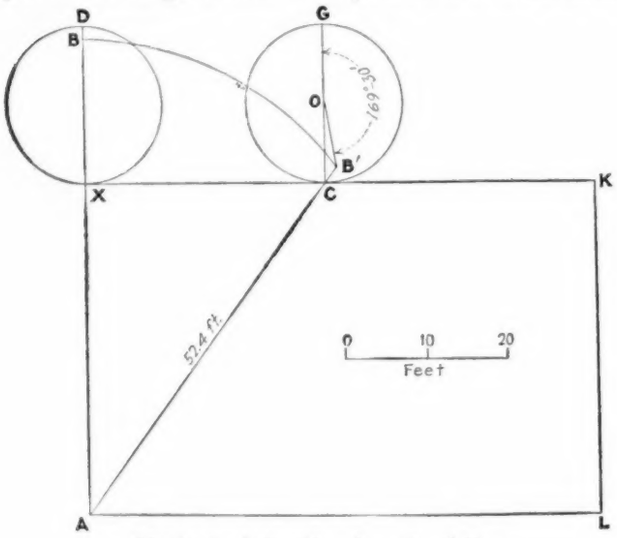
How Long Is the Line?

THE "Comments from Readers" column in the September 6 issue carried a problem submitted by E. S. Smail, which interested me considerably.

I have therefore developed two methods of attack, one of which is shown in the illustration. The point of least length, as referred to the position of the point *C*, proved somewhat surprising, but the results check so closely that there is no doubt of its accuracy.

A word with regard to the graphical method may not be amiss. The scale taken was 1 in. = 10 ft. in order to reduce the drawing to letter size. The rectangle *AK* represents the developed cylinder, and the circle *DX* the circular top in its original position.

The first step was to plot the trochoid *BB'*, using the point *B* as the generatrix. The position *GC* of the circle



Method of funding length of line

was then located by trial and error, such that the line *AB'*, representing the shortest length of the wire, passed through the point of tangency *C*. Three trial were required to do this. The results obtained were: Length, 52.4 ft.; angle (measured by 4-in. protractor), 169 deg. 30 min. This is the angle *GOB'*, which is angle *CBX* of Mr. Smail's figure.

The results obtained graphically are so close to those obtained mathematically, that the former method is greatly to be preferred. D. C. NUTTING.

Tacoma, Wash.

* * * *

Another Answer to "What Do You Know"

REFERRING to question No. 3 on page 389, issue of September 13, in the event the Corliss engine in question is of the "steam hook" disengaging type, it is only necessary to shorten the dashpot rod sufficiently to prevent the steam hook from opening the valve. On engines that do not operate at a speed in excess of 100 r.p.m., this can be done while the engine is in operation and is a much easier method of procedure than disconnecting the reach rod. The exhaust valve should be placed in the position as stated in the answer on page 396 of *Power*. JOHN F. HURST.

Louisville, Ky.

Answers to What Do You Know

The questions are on page 559

Ans. 1—The chamfering of tube holes on both sides of the tube sheet is to prevent the cutting effect of the sharp edge that is left after drilling or reaming. If the tube were to be rolled in firm and hard against such a sharp edge, it would suffer an appreciable indentation, or cut, leading to ultimate failure.

Ans. 2—The reason is that few steel mills can roll boiler plate wider than 12 ft. and it is desirable that boiler plate should be rolled so that its long axis of rolling will extend girthwise, or around the boiler shell. The plate is stronger in that direction, and the greatest stress in a cylindrical pressure vessel is girthwise. The Massachusetts rules do not place any such limit on the drums of water-tube boilers, but no reference is made to longer joints. The A.S.M.E. Code states that with butt and double-strap joint construction longitudinal joints of any length may be used if tension test specimens are cut from the plate in the girthwise direction.

Ans. 3—No. At this temperature a saturated mixture contains, by volume, twice as much air as gasoline, but the gasoline weighs 50 per cent more than does the air. Such a mixture will not explode until the air is increased by about ten times its volume.

Ans. 4—During the early part of the stroke the reciprocating parts must be accelerated, causing the pressure to be on that half of the wristpin bearing toward the piston top. At a point close to the middle of the stroke the velocity of the piston is at its maximum, and during the rest of the stroke the piston must be slowed down. This causes the pressure on the pin to be reversed, so that after passing this maximum velocity point the pressure is against the other half of the bearing.

Ans. 5—The intermediate pressure will change. At the third stroke it will rise to its new value of 34 lb. gage.

Ans. 6—Experiments have proved that dichromate of soda placed in the brine will stop ice-can corrosion.

Ans. 7—Start the Diesel generator as a synchronous motor drawing current from the steam-driven unit. To do this, close the field switches of each alternator so that current will flow from the steam-driven exciter. Set the rheostat so that only a low voltage is applied. Next connect both alternators to the busbar and start the steam engine. The exciter will supply current to both machines and the Diesel alternator will start as a motor. However, build up the exciter voltage as soon as possible to prevent the induced voltage from overheating the fields.

Ans. 8—The new pump would raise the water the necessary 14 ft., but since the vacuum created by the first pump cannot support a column of water 14 ft. high, no water will enter this pump.

Ans. 9—All the events are controlled by the single valve. If the load is light, cutoff must be early and, as a consequence, release, compression and admission are also made early.

Ans. 10—Two methods have been used. By the first the spindle is supported in the bearings with the weight taken up by a crane. The spindle is then hammered on the inner curvature of the bend until the shaft straightens. By the second method the wheels are removed and the shaft heated along the inner curvature until the shaft bends the other way. When cooled, the shaft will return to its original straighteners, although the heating may be needed several times before the shaft is in line.

Capacity of Up-Feed Steam Heating Risers*

By F. C. HOUGHTEN† and M. E. O'CONNELL‡

AN INVESTIGATION of critical velocity and its bearing on pipe sizes for steam heating systems was undertaken at the Research Laboratory of the American Society of Heating and Ventilating Engineers early in 1922. The object of this study was to determine the allowable velocities of steam with counterfloating condensate in various parts of a heating system. This work, temporarily brought to a close in 1924, was again undertaken in 1926, particular attention being paid to large risers for both one- and two-pipe systems.

For this investigation a four-story system shown in Fig. 1 was erected

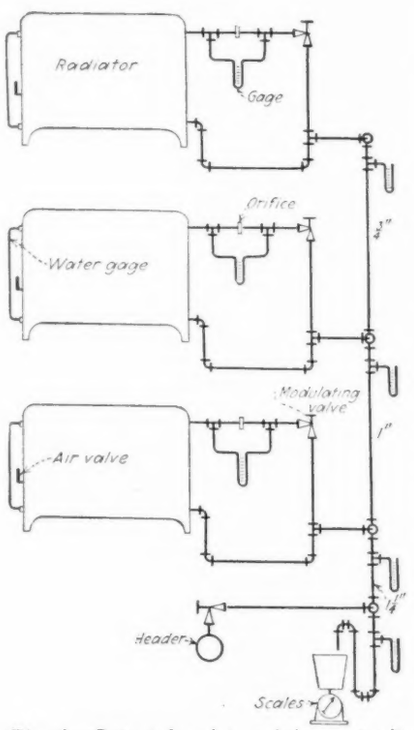


Fig. 1—Set-up for determining capacity of a compound riser

in Professor Dibble's laboratory at Carnegie Institute of Technology. It supplied steam to three levels through three sections of a riser each approximately 10 ft. in length. The riser size was $1\frac{1}{4}$-in. to the second floor, 1-in. to the third floor, and $\frac{3}{4}$-in. to the fourth floor. Steam was taken from an 8-in. main to a branch connection containing a valve. Branches to the radiators were from 3 ft. to 5 ft. in length and estimated to be large enough so that steam supplied to the radiators would be limited by the

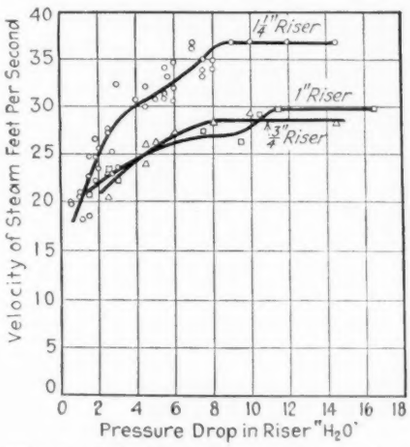


Fig. 2—Relation between pressure drop in a one-pipe system and velocity

riser rather than by any other part of the system.

In order to measure the steam flowing through each section of the riser, a special connection from the radiator branch to the radiator was adopted. Steam was taken from the radiator branch through a vertical pipe, a radiator valve and a calibrated orifice to the top radiator connection. The condensate from the radiator was taken from the lower radiator connection through a water sealed trap back to the radiator branch. This method of connecting the radiator to the branch is essentially a two-pipe connection. The riser and radiator branch, however, operate purely as a one-pipe system and should not be affected in any way by the unusual connection.

The steam flowing through each section of the riser was determined by adding the steam entering the radiator, as found from the calibrated orifice, to the condensation in the riser itself. These various distributed amounts were always compared with the total condensation from the system.

Figs. 2 and 3 show curves plotted from data collected with this set-up. In these curves velocity in feet per second and capacity in pounds per hour are plotted against steam-pressure drops between the main and the radiator, and indicate clearly the maximum capacity of the respective risers.

While tests with the orifice connection, shown in Fig. 1, gave the values indicated in Figs. 2 and 3 with no noticeable disturbance, it was thought that the orifice connection would tend to prevent the storage of water in the radiator and might also dampen any noise due to riser disturbance. This suggested trying the system with the radiator size adjusted so that they were just large enough to condense all the steam the respective risers could carry and to connect to the risers in the usual manner. A water gage connected to the end section of each radiator made it possible to detect accumulation of

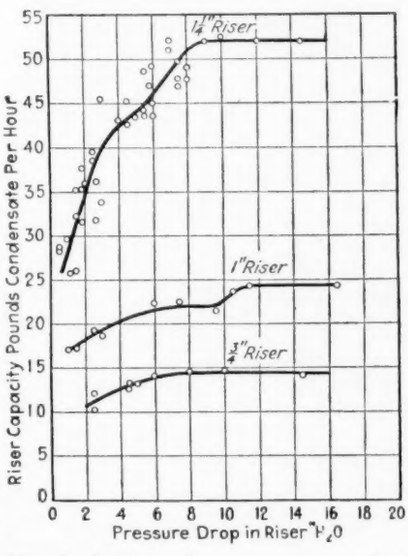


Fig. 3—Relation between pressure drop in a one-pipe system and capacity

water. It was found that the risers carried the maximum amount of steam shown in the curves without storing water in the radiator and without noise or intermittent return of condensate. If, however, the demand for steam was increased by enlarging the radiators or by increasing the condensation by directing a fan blast over the radiators, the

*Abstract from paper presented at the June meeting of the A. S. H. & V. E.

†Director of Research Laboratory, A. S. H. & V. E.

‡Research Physicist, A. S. H. & V. E. Laboratory.

water glass indicated that water was stored in the radiator and a gurgling sound could be heard at the radiator valve.

The system shown in Fig. 1 was then changed over to a two-pipe system and similar data obtained. It was found that there is also a limit to the capacity of

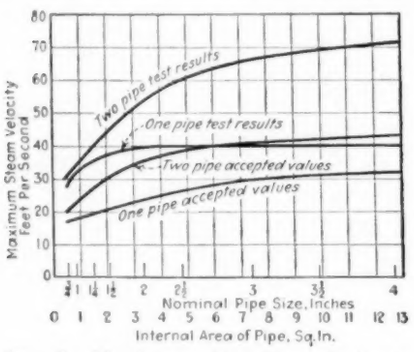

Maximum Steam Velocity Feet Per Second
Two pipe test results
One pipe test results
Two pipe accepted values
One pipe accepted values
Nominal Pipe Size, Inches
Internal Area of Pipe, Sq. In.

Fig. 4—Maximum allowable velocity in one- and two-pipe risers

risers in two-pipe systems. This capacity limitation is believed to be due to the condensation occcurring in the riser. The capacity of risers in a two-pipe system is, however, for the larger pipe sizes nearly double that of the one-pipe system.

Similar tests and curves were obtained for risers up to 4 in. size. The curves in Fig. 4 show the maximum steam velocity for various pipe sizes as obtained from the tests and also the recommended maximum velocities for practical work. It will be noticed that the curves on which practical values are based, show velocities lower than any obtained by tests in the laboratory. Analyses of these curves show that a fairly large factor of safety is allowed in the accepted velocity through small pipes. Defects in pipe are much more likely in small sizes and have a greater percentage effect on the capacity of the pipe, and also clogging of pipe due to corrosion or scale is more likely in small sizes.

To demonstrate the practicability of using the maximum capacities obtained in the laboratory, in an actual installation, tests were made on the heating system of a modern 12-story building. These tests showed that all sections of the risers would operate with complete satisfaction with velocities at least as high at 25.4 ft. per sec., while at least one riser would so operate at 36.8 ft. per sec. The data leave little doubt that if facilities were available for further increasing radiation on the different levels, all sections of the riser would have carried steam with counterflowing condensate at the velocity shown when the riser was tested in the laboratory or between 35 and 40 ft. per second.

What Is "Usual" Employment?

By Leo T. Parker

AT VARIOUS times the higher courts have been presented with the question, When is an employee engaged in his "usual" employment?

For example, in the case of Oilmen's Reciprocal Association vs. Gilleland, 291 S. E. 197, decided during the past few weeks, it was disclosed that a bricklayer was employed by a laundry company to build a brick wall for the purpose of lining an excavation intended to contain water pumps. While engaged at this work one side of the excavation caved in and killed the employee.

The lower court held the dependents of the bricklayer entitled to compensation, but the higher Texas court reversed the verdict and said:

"It is necessary, of course, that a laundry continuously and constantly have water. And a man employed to pump water to the laundry and thereby furnish this necessity, from day to day, would unquestionably be within the 'usual course' of the laundry business. He would be, just as would the machinist who looks after the boiler and furnishes steam power to the plant from day to day; or just as would the girls who actually do the washing or the boys who gather up the laundry and return it to the customers. But it seems inconceivable to us that it could reasonably be said that a bricklayer, working in connection with the digging of a new well, an incident most unusual and rare, was in the *usual* course of the laundry's business. In other words, laundries do not ordinarily engage in building brick walls in pits. During a great majority of the days of its operations, it engages in no such business. Therefore such an undertaking is not ordinary or customary, but exceedingly unusual and extraordinary."

The case of Callihan vs. Montgomery, 272 Pa. 56, 115 A. 889, by the Supreme Court of Pennsylvania, is interesting. In that case it was disclosed that a skilled mechanic had been engaged to repair an engine to run a pump under an agreement to be paid by the day. In this case the widow of the deceased workman was held not entitled to receive compensation. This court rendered a lengthy opinion explaining the law on the subject, and, in part, said:

"The casual employment of one, for the performance of an odd job, may occur in conducting a business and still not be within its regular course. For instance, emergency repair work on a machine used in operation of a business can always be said to take place in the course of that business, as all machinery at some time or other is bound to need repair; but such work, if not of a kind usually performed by or under the control of the person conducting the business, would be outside the regular course thereof. The Legislature evidently intended, by the use of the words 'regular course,' to give them some definite significance, and the most natural meaning is that they refer to the normal operations which regularly constitute the business in question, excluding incidental or occasional operations arising out of the transaction of that business, such as now and again repair the premises, appliances or machinery used therein. While repair work may be considered an important incident to any business using machinery, and, in some cases, may enter into the customary operation of such a business (for example, when men are engaged as regular employees for the purpose of keeping the machinery in order), yet the repairs we are here considering were no part of the regular course of the business conducted by defendant . . . they represent merely an odd job, incidental to that business, but not part of the work ordinarily done by or under the control of the employer in this particular case."

In the case of Holbrook vs. Hotel Co., 200 Mich. 597, 166 N. W. 876, a workman while enaged in painting was injured. Compensation was denied him. The Supreme Court of Michigan in that case spoke as follows:

"It is clear that the law contemplates that there may be an employment of labor, not in the usual course of the business of the employer, in which employment the risks of injury not occasioned by the employer's fault are assumed by the workman. It would seem that occasionally renovating the rooms of a building, or the building itself, owned and occupied . . . with paint or paper or both is not in the usual course of the trade, business, profession or occupation of the owner, unless he is himself in the business of painting and decorating. No reason can be found for concluding that the owner is pursuing his business, with the meaning of the law, when he causes the rooms to be occasionally painted and decorated, although it is usual to have work of that nature done from time to time."

On the other hand, in the case of Caca vs. Woodruff, 70 Ind. App. 93, 123 N. E. 120, a carpenter was injured while employed to assist in erecting an additional part to a mill where wheat and corn were ground and food stuffs manufactured. He was held entitled to recover compensation for the injury although he was not following the usual course of trade, business or profession of his employer at the time of the injury.

A review of the higher court decisions illustrates the contention that the use of the word "usual" puts a quite different meaning on the definition of the employee than if it were omitted, and in these cases it has been generally held that an employee is not entitled to compensation under the workmen's compensation law, where he is injured while working at something not "usual" to the employer's business.

NEWS *of the* FIELD

Fulton Iron Works Purchases Large Interest in Foos Engine Co.

H. J. Steinbreder Elected Chairman of Board—George Foos as President—All Sales Will Be Handled by Fulton Organization

ANNOUNCEMENT has been made that Harry J. Steinbreder, president of the Fulton Iron Works Co., St. Louis, Mo., has been elected chairman of the board of the Foos Engine Co., Springfield, Ohio.

The Fulton Iron Works Co. has purchased a substantial part of the stock of the Foos company. In accordance with the concerted plan the sales efforts of the two concerns will be co-ordinated, which, however, will permit each company to retain its identity.

Coincident with the announcement of the election of Mr. Steinbreder, information was given out following meetings of stockholders and directors of the company that George Foos, son of John Foos, founder of the business in 1887, has been named president of the company.

This arrangement permits the handling by the Fulton sales organization (both domestic and foreign) of a complete line of Diesel engines, ranging in size from 10 to 2,000 hp., for stationary, marine, dredge, power boat, portable uses, such as air compressors, shovels, drag lines, etc., and locomotive and rail cars. The Foos engines manufactured at the Springfield plant range from 10 hp. to 400 hp. units. The Fulton Iron Works Co. has since 1913 been an important factor in the field of larger engines, its products ranging from 300 to 1,500 hp. units. These will continue to be manufactured at the Fulton plant in St. Louis, Mo.

Separate Plants Retained

By the grouping of the sales efforts of the two plants, it was pointed out by Mr. Steinbreder in an interview, a complete range of small and large engines can be offered to the market through one sales organization.

The present plant of the Foos company, he declared, is adequate for handling the line of 10- to 300-hp. engines, while the St. Louis plant of the Fulton Iron Works is adequate to handle the 400- to 1,500-hp. units.

Mr. George Foos will in the near future take over the active management of the Springfield plant. The developments are looked upon as preliminary steps to an aggressive business expansion program involving numerous advantages to both companies.

In addition to the election of Mr. Steinbreder and Mr. Foos, a change in the stock structure of the local company was effected at the meeting of stockholders, when it was voted to increase the capitalization. The stock in the company at present is represented by 1,600 shares of common stock, most of which has been issued. The change calls for 16,000 shares of no par common stock.

Although the Fulton Iron Works Co. has acquired a substantial interest in the Foos concern, the controlling interest of more than 50 per cent of the outstanding stock will remain, according to the *Springfield Daily News*, in the hands of Miss Margaret Baker, secretary and treasurer of the company, who retains those positions under the new lineup.

Electric Bond & Share Buys Foreign Utilities

The acquisition of public utilities in Brazil, Colombia, France, Japan and other foreign countries at a cost of $36,417,597 by the Electric Bond & Share Co. and a proposal of their transfer to the American & Foreign Power Co., Inc., a subsidiary, were announced October 1.

The Brazilian acquisitions of the Electric Bond & Share Co. include electric and railway companies in Petropolis, electric companies in Nictheroy, electric and railway companies in Bahia and environs, electric companies in Victoria and Itapemirim and environs, railway companies in Victoria, electric companies in the State of São Paulo and telephone properties in Victoria and Bahia. Colombian properties acquired included electric companies in Barranquilla and vicinity. American and Foreign Power Companies operate in Cuba, Panama, Guatemala and Ecuador.

Harbison-Walker Acquires Walsh Fire Clay Co.

Through an exchange of stock, the Harbison-Walker Refractories Co., of Pittsburgh, has acquired the Walsh Fire Clay Products Co., of St. Louis, Mo.

The Walsh plant at Vandalia, Mo., situated in the St. Louis field, with a daily capacity of some 150,000 9-in. firebrick, thus increases the capacity of Harbison-Walker by about 10 per cent.

The Walsh Fire Clay Products Co. is one of the oldest producers in the St. Louis district. Its plant has within recent years been completely modernized with the introduction of continuous kilns and the most modern type of clay-working machinery.

Harbison-Walker has hitherto had no plants west of the Mississippi. This development rounds out its production to include all the major fields of the ceramic industry.

Large Condenser and Stokers for Brooklyn Edison

The Brooklyn Edison Co. has recently placed an order with the Westinghouse Electric & Manufacturing Co. for a single-pass surface condenser which when installed will be, it is reported, the largest of its kind in the world.

This condenser is necessary to condense the exhaust steam from the 110,000 kw. turbine-generator to be installed in the Hudson Avenue Generating Station during 1928. The condenser will contain 14,400 brass tubes with a total surface area of 85,000 sq.ft. East River water will be circulated through the condenser at the rate of 135,000 gal. per minute, which will require the use of two centrifugal pumps driven by 400-hp. electric motors. Its total cost including auxiliaries will be about $350,000.

Another order which the Edison company recently placed with the Westinghouse Electric & Manufacturing Co. covers the furnishing of four mechanical stokers which will be used in connection with 24,000 sq.ft. boilers. The stokers will be of the latest underfeed type, equipped with electric driving motors, grinders to dispose of the ash, and a new shaking grate mechanism designed to permit the most efficient burning of the coal at high combustion rates. Each stoker will be capable of burning approximately 20 tons of bituminous coal per hour without objectionable smoke, which will enable the boiler when thus fired to generate 350,000 lb. of steam at 400 lb. per sq.in. pressure.

Plans 45,000 Hp. Unit

In order to provide additional capacity at Shawinigan Falls, Quebec, and to balance better the hydraulic plants on the St. Maurice River, the Shawinigan Water & Power Co. will immediately begin construction of the seventh unit in power house No. 2. This unit will be 45,000 hp. and a duplicate of the last unit installed.

Thompson-Owens Corp. Forms To Make Castings, Bearings

A new company has entered the manufacturing field of bushings, bearings, castings, with the recent incorporation of the Thompson-Owens Corp., of Toledo, Ohio. The products of the company, it is announced, will cover a full line of finished bronze bushings and bearings and brass and bronze castings.

Heading the company as president and general manager will be George Thompson, whose duties will include charge of all production. Mr. Thompson for the last ten years was associated with the Bunting Brass & Bronze Co. in the capacity of general manager and works superintendent and manager. J. E. Owens, who was connected with the Bunting Brass & Bronze Co. for fourteen years as salesman and sales manager, will serve in the capacities of secretary and treasurer.

A modern plant, including foundry, located on the Toledo Terminal Railroad has been acquired, and is being completely equipped with new machinery. It is expected to be in operation by the middle of the month or November 1.

Conference at Berlin on Engineering Materials

Preparations for the Conference on Engineering Materials which is to take place in Berlin from October 22 till November 13 have already far advanced. The program of papers contains about 200 lectures to be read by scientists and practical engineers. Foreign scientists will be the speakers especially in some series of lectures to be held on October 31.

While these papers, which are read at the Technical University of Charlottenburg are intended chiefly for engineers, an exhibtion of engineering materials arranged in the Neue Ausstellungshalle on the Kaiserdam will be an attraction for the general public also.

More than 200 testing machines, which will be shown in operation will introduce the visitors into the latest methods of testing, which are not familiar even to many engineers. Many inquiries on the part of foreign diplomats accredited in Berlin prove that the continental and oversea engineering world is highly interested in this new and unique congress.

Detailed particulars are given by the "Geschäftsstelle der Werkstofftagung," Berlin NW7, Ingenieurhaus.

Calls for Simplification of Transmission Equipment

The United States Division of Simplified Practice, Department of Commerce, and the Leather Belting Club of Chicago have called for a simplification of transmission and belting equipment. Probably the activity will be centralized in the Power Transmission Association, W. S. Hays, secretary, Drexel Building, Philadelphia. Remarkable results have been accomplished in Germany, it is claimed, through the working out of a simplification plan in that country.

Center of Industry Continues Westward Movement

According to calculations recently made by the Geological Survey, Department of the Interior, the center of industry in the United States in January, 1926, was about 50 miles southeast of Chicago. This point is approximately near Valparaiso, Indiana, about 170 miles due north of the 1920 center of population near Whitehall, Indiana, and about 640 miles east by north of the geographic center, somewhere near Smith Center, Kansas.

This determination of the center of industry is based on the capacity of steam engines, steam turbines, water wheels and internal combustion engines installed in manufacturing plants and in public utility power plants. Twice the weight is given to the power equipment in public utility plants, as it is used twice as much as that in manufacturing plants. This method is believed to give more representative results than previous determinations of the center of industry which have been based only on the installed capacity of prime movers in manufacturing plants.

Bureau of Standards Regroups Work Under Two Heads

An important change in the administrative organization of the Bureau of Standards, which it is believed will make for increased efficiency through a better grouping of the Bureau's numerous activities, was announced September 30.

Under the new arrangement Dr. L. J. Briggs has been appointed assistant director in charge of research and testing, while Mr. Ray M. Hudson becomes assistant director in charge of commercial standards.

According to the plan the Bureau's activities will be divided into two main groups. The first, under the immediate supervision of Doctor Briggs, will include all the Bureau's scientific research and testing, the development, construction, custody and maintenance of reference and working standards, and their intercomparison improvement, and application in science, engineering, industry and commerce. The second group, headed by Mr. Hudson, will include the supervision, direction, formulation and co-ordination of commercial standards, with particular reference to the needs of industry, involving the oversight of the division of simplified practice, division of commercial standards, and part of the work of the division of building and housing relating to codes and standards.

No "Struggle" Seen in Canadian Power Control Situation

An analysis of the power control situation in Canada published recently by the Toronto *Globe* gave reply to rumors that a three-cornered struggle is now in progress for the great water-power sites of the Dominion. "Evidence in possession of the government's experts," says the *Globe*, "shows that there is considerable competition in the province of Quebec for available power sites, but the rival companies are confining their activities to Quebec, and a survey of the power situation from the Atlantic to the Pacific reveals the fact that Canadian capital is in control where private enterprise is encouraged, while in Ontario and other provinces which are partial to public ownership there is no great invasion of United States or British capital.

"Rivalry among power corporations, it is pointed out, is confined largely to Quebec province, where the Gatineau Power Co., a subsidiary of the International Paper Co., is competing with the Shawinigan interests. Both corporations are acquiring smaller companies which own or control power sites in various parts of the province."

San Francisco Engineers' Club Dedicates New Home

The goal of many years' endeavor was reached by the Engineers' Club of San Francisco when its new home was dedicated on Sept. 30. This club, which is now fifteen years old, includes in its membership engineers engaged in all branches of the profession, the total membership being about 750.

Because San Francisco is far from the headquarters of the national engineering societies the Club has made a point of close relationship with these organizations. The four founder societies in conjunction with the Club conduct an employment service in San Francisco and thirteen branches of national technical societies hold meetings at the Club. The new quarters occupy the two top floors, 14th and 15th, of a new building at Pine and Sansome Sts.

Electrical Exports Continue Rise

Exports of electrical equipment from the United States for the eight months ended August 31 showed an increase over the same period last year, amounting to $65,145,935, or a gain of $2,107,243, according to the Electrical Equipment Division of the Department of Commerce. The value of August shipments was $8,139,241, or $1,111,479 more than for the same month last year.

The outstanding increases were for batteries, rectifiers, double current and motor generators, dynamotors, synchronous and other converters, motors under 1 horsepower, and electric lamps.

September's Crop of Water Power Applications

Five applications for permit or license under the Federal water power act filed with the Commission during the period August 21 to September 29, 1927, making a total of 838 applications received, include those to:

B. G. Slining has applied for a preliminary permit to construct a power project on the Big South Fork of the Cumberland River in McCreary County, Ky., and Scott, Pickett and Fentress Counties, Tenn. The proposed project will be in the vicinity of Stearns, Ky., and will consist of a masonry dam 375 ft. high and power house at Devils Jump site. It is expected that 100,000 hp. will be developed, which will be used for public utilities. The application conflicts with those previously filed by H. A. Spalding and Dr. E. A. Allen.

The Twin Harbor Land Co. has applied for a preliminary permit to construct a dam 110 ft. high, together with penstocks, a power house, transmission line and reservoir, on North River, near Aberdeen, in Grays Harbor and Pacific Counties, Washington. The power proposed to be developed will be used for public utility purposes.

The Seafoam Mines Corp. has applied for a perliminary permit to construct a rock-fill timber dam 96 ft. long, to divert water from Float Creek, in Custer County, Idaho, through a timber flume to a power house, where it is proposed to generate power for use in mining and milling purposes.

The Arizona Edison Co. has applied for a preliminary permit to construct a dam 260 ft. high and 1,700 ft. long on the Gila River, in Graham and Greenlee Counties, Arizona. The company proposes to develop from 9,000 to 19,000 hp. for public-utility purposes.

John R. Maurstad has applied for a license to construct a log crib dam 2 to 3 ft. high, 150 ft. long, diverting water through a pipe line 650 ft. in length, from Hidden Falls Lake into Kasnyka Bay, Baranof Island, Alaska. Hydroelectric machinery to a capacity of 400 hp. will be installed, the developed power to be used in operating a sawmill.

Canada To Decide Shortly on St. Lawrence Co-operation

Advices from Washington that the United States Government is anxious to secure the co-operation of Canada in furthering the proposed St. Lawrence navigation and power project, have elicited the information that the question will be discussed by the Canadian Cabinet sometime before the end of October.

Government officials and members of Parliament at Ottawa are not very enthusiastic over the scheme. The situation is that a joint board of engineers reporting on the scheme failed to agree as to whether the work should be carried out in single or double stages but, in appendices to this report, recently completed, it is said that this breach in opinion has been much narrowed. Reasons that are political as well as economic have always suggested a cautious and leisurely treatment of the subject at Ottawa and, Government authorities state that regardless of Washington's insistence that some action be taken in the matter, there is little prospect of this course being varied.

Declares "Security Wage" Need of Worker in Industry

A "security wage," by which the worker in industry has a margin above basic living costs to make his own provision against sickness, unemployment and old age, should be an objective in all industry, Edward J. Mehren, vice-president and chairman of the editorial board of the McGraw-Hill Publishing Co., told the New York Building Congress at a luncheon in the Hotel Commodore here today. The "security wage," he added, gives the worker independence and removes the necessity for his reliance upon state insurance schemes.

In his talk, Mr. Mehren described for his hearers the movement for reduction of production costs which industry in all parts of Europe, notably in Germany, is pushing through to success. It has dawned on the manufacturer in Germany, the speaker said, that well-paid workers are good customers and that good customers keep factories busy. Of course, the manufacturer is not rushing at once to raise wages, but his former resistance to wage increases is tempered by the conviction that his prosperity is tied up with his workers. Further, labor in Germany sees that the means for raising the wages of the workers will come from the savings effected through the cost reduction movement.

GERMANY AS FORMIDABLE COMPETITOR

"The significance for America in these cost reduction efforts lies in the new grip which they give Europe in foreign markets," said the speaker. "In fact, they will help in the constant effort to sell here in America in competition with our own industries. With Germany under the terrific urge of a lost war, adopting our production methods, often using American machinery and with a lower wage scale we shall be hard put to it to match her costs. We may, to an extent, keep her out of our markets by the tariff, but we can meet her in foreign lands only by producing at the world price. Further, while the American people have always stood for a certain amount of dumping, that is for the sale of products abroad for less than they are sold here, it is doubtful whether they will stand for it on a grand scale. Should they refuse to permit it, the tariff walls will be lowered and we shall need more than ever to manufacture at or below the world price."

Tri-City Engineers Hold Joint Meeting

The Tri-City Chapters of the American Society for Steel Treating, the American Society of Mechanical Engineers and the Davenport Engineering Club held a joint meeting September 30 at the Rock Island Arsenal, Davenport, Iowa. The guests made a tour of the arsenal machine shop under guidance of arsenal officers. A 23-ft. structural steel launch for river work, machined surfaces used in gun carriages and some artillery developed since the war were exhibited.

Obituary

FRANK EDGAR IDELL, member of the American Society of Mechanical Engineers, New York representative of the Cochrane Corp., died at his summer home in Allentown, N. J., September 29. Mr. Idell succumbed after a short illness at the age of 71. Having graduated from the Stevens Institute of Technology in the class of '77, the degree of Doctor of Engineering was conferred upon him by that institution in 1921. For forty years he was New York agent for the Harrison Safety Boiler Works, which afterward merged with the Cochrane Corp. of Philadelphia. Mr. Idell was a member of the Engineers Club, the University of Brooklyn, the Brooklyn Chamber of Commerce and the Delta Tau Delta fraternity.

Inadvertently, Mr. Idell's name was given erroneously as Frank Feidell, when his death was reported to *Power* and announced in last week's issue.

Personal Mention

A. D. CAMERON has been appointed manager of the street lighting and supply division of the central station department, and there has been set up in the same department a holding company division with W. P. White as manager.

MAJOR GENERAL W. B. LINDSAY, who was chief engineer with the Canadian forces during the war, has been making an extensive study of the use of lignite coal to generate power and manufacture byproducts and has gone to England and Germany to continue his study of such development.

H. K. GOWDY has recently joined the Elliott Company organization as sales engineer in the Boston territory. He was chief engineer of the Homer Street power plant of the Newton & Boston Street Railway. Later he was chief engineer of the Connellsville Plant of the West Penn Power Co., superintendent of power plants for the Pittsburgh Railways, and chief steam engineer for the Cambria Steel Co.

C. P. DUNN, formerly hydraulic engineer with the Aluminum Company of America, Pittsburgh, is now chief engineer for the Portland Electric Power Co., Portland, Ore.

W. M. STEARNS has been transferred from the central station department of the General Electric Co. to the general commercial department and has been appointed manager of special contracts. He will also act as an assistant to Vice-President J. G. Barry.

J. B. HILL, electrical engineer until recently manager in charge of the Ohio Utility Co. properties of the United Light & Railways Co., Davenport, Iowa, has accepted a new connection with the American Gas & Electric Co., in plant operation. Mr. Hill was formerly associate professor of electrical engineering at the State University of Iowa.

LORAN D. GAYTON has been appointed city engineer by Richard W. Wolfe, Commissioner of Public Works. Mr. Gayton assumed his duties Sept. 1. Mr. Gayton has designed pumping stations and other municipal buildings worth $7,000,000. He now takes the office held by John Ericson, whose death several months ago terminated a career of forty years in public service. Mr. Gayton entered the designing division of the Bureau of Engineering, a department under the supervision of Mr. Wolfe, in 1913, as a draftsman. In the fourteen years since he has been elevated several times, but has always remained in that department. Until his recent appointment he was for several years engineer in charge of the designing division.

CLAUDE A. BULKELEY, formerly with the E. I. duPont de Nemours & Co., has joined the Niagara Blower Co., Buffalo. He will have direct supervision over the design and installation of all air conditioning equipment. Mr. Bulkeley is a member of the American Society of Mechanical Engineers, American Society of Civil Engineers, and American Society of Heating and Ventilating Engineers.

E. H. HASLAM has recently been made district manager of Elliott Company's Chicago district office. His early work was with Mackintosh-Hemphill & Co., Pittsburgh, designers and builders of steam engines, rolling-mill machinery and other equipment to be used in iron and steel work. With this company Mr. Haslam worked up from draftsman to chief engineer, vice-president and general manager. In 1920 he went with the Steel & Tube Company of America, where his duties included the supervision of all engineering as well as new construction. When this company was merged with the Youngstown Sheet & Tube Co., Mr. Haslam resigned to take up consulting work in Chicago. For a few years he served as superintendent of the Pittsburgh Works of the Pressed Steel Car Co. He is a member and for a time served as director of the Engineering Society of Western Pennsylvania. He is also a member of the A.S.M.E. and the Iron & Steel Institute.

WILLIAM G. HODGE has been elected a vice-president of the Byllesby Engineering & Management Corp. Mr. Hodge has been connected with the Byllesby organization since 1910, as manager of the advertising and publicity department. His present position will carry with it the management of a newly created sales and advertising department of the company at its Chicago office.

C. N. CHUBB, who became general manager of the Peoples Light Co., Davenport, Iowa, ten years ago and has since been vice-president of the United Light & Power, Engineering & Construction Co., is now president of the Iowa-Nebraska Light & Power Co., a subsidiary of the United Light & Power Co. Mr. Chubb assumes, November 1, his new duties with headquarters in Lincoln, Neb. He will also be president of the Lincoln Traction Company.

Mechanical Stokers, Sales (New Orders) 1920-1926

THIS table of stoker sales, compiled by the United States Department of Commerce, Bureau of the Census, represents the output of practically the entire industry. From 1919 through 1922 the data were compiled by the Stoker Manufacturers' Association from 15 firms for most of the period, and are comparable with the later figures arranged by the Department of Commerce, beginning with 1923, from 13 firms (15 prior to August, 1924, when 4 establishments consolidated into two). In 1919 a total of 2,809 stokers were sold, with horsepower amounting to 632,795. There are no monthly figures for 1919.

This information is to be included in the Metals Section of the Record Book of Business Statistics, which is being published by the Bureau of the Census.

TABLE 25—MECHANICAL STOKERS, SALES (NEW ORDERS) 1920-26

Month	1920	1921	1922	1923	1924	1925	1926
	Number of Machines						
January	218	37	81	145	91	57	72
February	263	46	75	129	110	135	83
March	664	52	116	120	89	131	132
April	180	96	125	167	89	120	145
May	159	68	143	194	64	122	129
June	126	76	109	135	102	128	175
July	181	98	177	129	115	147	125
August	142	116	160	135	94	91	104
September	122	110	115	99	73	119	127
October	66	54	*156	88	104	114	112
November	40	60	†96	50	106	76	85
December	34	58	‡208	73	91	108	72
Total	2,195	871	1,563	1,464	1,128	1,348	1,361
Monthly average	183	73	130	122	94	112	113
	Total Horsepower						
January	70,327	10,921	34,157	83,270	66,492	27,871	36,913
February	109,688	17,521	35,663	66,619	62,113	46,298	33,141
March	245,570	23,053	69,716	68,955	34,597	71,099	52,312
April	54,692	29,651	62,027	85,339	47,939	47,627	70,055
May	40,712	40,889	61,391	100,513	34,447	55,588	48,482
June	50,164	30,597	37,239	59,719	35,549	44,095	68,408
July	45,748	34,073	70,230	52,518	37,759	58,719	50,494
August	51,828	44,586	83,310	71,693	41,931	29,865	38,852
September	71,229	36,401	40,505	60,486	25,988	38,155	44,211
October	27,203	17,596	*63,167	32,576	58,565	53,451	40,780
November	13,224	21,626	†35,808	16,241	37,167	33,461	27,606
December	10,649	20,224	‡131,699	32,517	31,732	47,104	34,974
Total	791,304	327,138	724,912	730,446	514,279	553,333	546,228
Monthly average	65,920	27,262	60,409	60,871	42,857	46,111	45,519

*One company missing. †Two companies missing. ‡Three companies missing.

Society Affairs

THE AMERICAN ENGINEERING COUNCIL'S administrative board has been called to meet at York, Pa., October 20. Sessions will last two days. The president of the Council, Dean Dexter S. Kimball, of Cornell University, will preside.

AFFILIATED TECHNICAL SOCIETIES OF BOSTON.—Designers Section, B.S.C.E. will hold a meeting 715, Tremont Temple, October 13, at which George Haggas of the Cumberland Power & Light Co. will talk on the structural design features of a hydro-electric development at West Buxton, Me.

POWER TRANSMISSION ASSOCIATION'S annual meeting is to be held December 7 at the Hotel Commodore, New York City, during the week of the Power Show. A program is being arranged bringing out the co-operative development of better relations with users of power transmission equipment that has marked the year's work on the part of the membership.

Business Notes

The ROLLER-SMITH Co., 233 Broadway, New York City, announces the [illegible]ntment of the D. H. Braymer Equipment Co., W. O. W. Building, Omaha, Neb., as its representative for Nebraska and western Iowa. D. H. Braymer is at the head of this organization. The D. H. Braymer Equip-

ment Co. will handle Roller-Smith instruments, relays and circuit breakers in the territory specified.

THE CONSUMERS POWER CO., Kalamazoo, Mich., is having installed a complete district heating plant to serve the business section of Kalamazoo. The contract for the underground installation has been given to the Northeastern Piping & Construction Corp. of North Tonawanda, N. Y., and installation is proceeding rapidly.

THE NORTHEASTERN PIPING & CONSTRUCTION CORP. of North Tonowanda, N. Y., has undertaken a contract let by the Board of Water and Electric Light Commissioners of the city of Lansing, N. Y., for the installation of a high-pressure steam transmission line to convey steam at 300 lb. pressure from the Cedar Street plant to the Ottawa Street plant in Lansing.

THE NIOBRARA RIVER POWER CO., Spencer, Neb., has been incorporated with $100,000 capital to build a 50-ft. dam a mile wide on the Niobrara River. This power plant will be seven miles southeast of the Northern Nebraska Power Co.'s dam and is sponsored by men who are interested in that project. E. A. Forbes, W. D. Bradstreet and A. W. Person are listed as incorporators.

Trade Catalogs

MAXIM SILENCERS.—The Maxim Silencer Co., Hartford, Conn., has issued an illustrated bulletin on Maxim Silencers, emphasizing the use of this apparatus on engine exhausts, air compressor suctions and small vacuum pump discharges. Installations are depicted, and a model chart is given.

DRY QUENCHING OF COKE—The Dry Quenching Equipment Corp., 200 Madison Ave., New York City, has recently issued a 4-page bulletin which describes the Sulzer system for the dry quenching of coke. This system is designed to recover the sensible heat of the hot coke and utilize it for steam generation by circulating an inert gas through a container into which the glowing coke has been delivered.

FUEL BURNING EQUIPMENT — "The Most Economical Method of Burning Coal" is the title of a new bulletin No. 979 just published by the Detroit Stoker Co. The bulletin outlines the factors to be considered in selecting fuel burning equipment, with a brief discussion of the several points. The various types of Detroit stokers, including multiple retort rear cleaning for large boilers requiring high duty; double retort [illegible] cleaning stoker for medium bo[illegible] single retort stoker, side cleaning, for small to medium boilers of 100 to 300 hp. each; the unistoker, which is a modification of the single retort side cleaning stoker, having the motor and fan attached as a single independent unit; and industrial stokers for all services, are illustrated. Copies may be had by addressing the Detroit Stoker Co., 979 General Motors Bldg., Detroit, Mich.

Coming Conventions

American Boiler Manufacturers Association, winter meeting, Hotel Cleveland, Cleveland, Feb. 7; A. C. Baker, sec., 801 Rockefeller Bldg.

American Society of Civil Engineers, fall meeting at Columbus, Ohio, Oct. 12-15; meeting headquarters will be at the Neil House; address F. H. Waring, Chief Engineer, State Department of Health, Columbus, Ohio.

American Society of Heating & Ventilating Engineers, hold general meeting in New York City, during 4th week in January; A. V. Hutchinson, sec., 29 W. 39th St., New York.

American Society of Refrigerating Engineers, annual convention in New York, Dec. 5-7; W. H. Ross, sec., 37 W. 39th St., New York City.

American Water Works Association. North Carolina Section, at Durham, Nov. 7-9; H. G. Baity, sec., Univ. North Carolina, Chapel Hill; Section, at Council Bluffs, Annual meeting, Hotel Fairmont, San Francisco, June 11-16; W. M. Niesley, 170 Broadway, New York City.

American Socity of Mechanical Engineers, convention during week of New York Power Show, New York City, Dec. 5-10; Calvin Rice, sec., 29 West 39th St., New York City.

Midwest Power Conference and Exhibition, at Chicago, Feb. 14-17; G. E. Pfisterer, sec., 53 West Jackson Blvd., Chicago.

National Association of Practical Refrigerating Engineers. Eighteenth annual convention and educational exhibition in Civic Convention Hall and headquarters Hotel Whitcomb, San Francisco, Calif., Nov. 29 to Dec. 2. H. Fox, 5707 W. Lake St., Chicago, Ill.

National District Heating Association, annual meeting in May; D. L. Gaskill, sec. 112 West 4th St., Greenville, Ohio.

National Fuels Meeting, under the auspices of the Fuels Division of the American Society of Mechanical Engineers, will be held at the Hotel Statler, St. Louis, Mo., Oct. 10-13. Address inquiries to William G. Christy, Citizens' Smoke Abatement League, Chamber of Commerce Bldg., St. Louis, Mo.

New York Power Show (National Exposition of Power and Mechanical Engineering) will be held at the Grand Central Palace, New York City, Dec. 5-10. Address inquiries to the International Exposition Co., Grand Central Palace.

CONDENSED CATALOGS OF MECHANICAL EQUIPMENT—The American Society of Mechanical Engineers, 29 West 39th St., New York City, has published the seventh annual edition of condensed catalogs of mechanical equipment. This edition has a total of 708 pages of data carried by 562 firms. The illustrations number more than 3,500. The volume is divided into three sections, the first comprising condensed, uniformly presented catalog information covering the products of the manufacturers of various classes of mechanical equipment, the second a general classified directory of manufacturers in the mechanical field, which is specialized, cross-indexed list of mechanical equipment with names and addresses of the manufacturers. The catalog closes with a professional engineering service directory describing the services of engineers in this field.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Sept. 28 1927
Pool 1	New York	$2.50@$2.65
Smokeless	Boston	1.48
Clearfield	Boston	1.60@ 1.85
Somerset	Boston	1.70@ 1.90
Kanawha	Columbus	1.50@ 1.75
Hocking	Columbus	1.75@ 2.00
Pittsburgh	Pittsburgh	1.90@ 2.00
Pittsburgh gas slack	Pittsburgh	1.35@ 1.50
Franklin, Ill.	Chicago	
Central, Ill.	Chicago	
Ind. 4th Vein	Chicago	
West Ky.	Louisville	2.00@ 2.25
S. E. Ky.	Louisville	1.50@ 1.75
Big Seam	Birmingham	1.65@ 2.00
Anthracite (Gross Tons)		
Buckwheat No. 1.	New York	2.90@ 3.25
Buckwheat No. 1.	Philadelphia	3.00@ 3.75
Birdseye	New York	1.50@ 1.60

FUEL OIL

New York—Oct. 6, light oil, tank-car lots; 28@34 deg. Baumé, 5c. per gal.; 36@40 deg., 5¼c. per gal. f.o.b. Bayonne, N. J.

St. Louis—Sept. 28, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.60 per bbl.; 26@28 deg., $1.65 per bbl.; 28@30 deg., $1.70 per bbl.; 30@32 deg., $1.75 per bbl.; 32@36 deg., gas oil, 4.4c. per gal.; 38@40 deg., 5.1c. per gal.

Pittsburgh—Sept. 27, f.o.b. local refinery; 30@34 deg., fuel oil, 4¾c. per gal.; 36@40 deg., fuel oil, 5c. per gal.

Philadelphia — Oct. 5, 26@30 deg., $2@$2.06 per bbl.; 13@19 deg., $1.68@ $1.74 per bbl.; 22 plus, $1.79@$1.85; 27@30, $2.10@$2.16.

Cincinnati — Oct. 3, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5¼c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5¾c. per gal.

Chicago—Oct. 1, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 22@26 deg., 87½c. per bbl.; 26@30 deg., 90c.; 30@32 deg., $1.05.

Boston—Oct. 3, tank-car lots, f.o.b. 12@14 deg. Baumé, 4¼c. per gal.; 28@ 32 deg., 5.9c. per gal.

Dallas—Oct. 1, f.o.b. local refiners, 26@30 deg., $1.45 per bbl.

NEW PLANT CONSTRUCTION

Calif., Inglewood—Los Angeles Railway Co., Railway Bldg., is receiving bids for the construction of an automatic sub-station at North Prairie Ave.

Calif., Long Beach—City will soon receive bids for the construction of two pumping stations. Estimated cost $500,000.

Calif., Los Angeles—County Supervisors, will receive bids until Oct. 17 for the construction of pole lines and transformers stations.

Calif., Salinas—Salinas Ice & Cold Storage Co., awarded contract for the construction of an ice and cold storage plant to La Faver Engineering Co., 545 2nd St., San Francisco. Estimated cost $150,000.

Calif., Yuba City—State of California, is having plans prepared for the construction of a pumping plant on east bank of Sutter-Butte by-pass to drain adjacent lands cut off from drainage by-pass leeves. Estimated cost $22,000. State Dept. of Pub. Works, Strub Bldg., Sacramento, is engineer.

D. C., Washington—Bureau of Standards, Dept. of Commerce, awarded contract for the construction of a power plant to Arthur L. Smith & Co., 2525 Pennsylvania Ave. Estimated cost $157,200.

Ill., Chicago—S. C. Finck, 35 South Dearborn St., Archt., is receiving bids for a 13 story apartment including electric refrigeration system, elevators, etc. at Sheridan Rd. and Glenlake Ave. for M. S. Willens, 160 North La Salle St. Estimated cost $2,000,000.

Ind., Hammond—Kaufman & Wolf, will soon award contract for a 4 story department store at Hohman St. Estimated cost $1.250,000. A. S. Alschuler, 28 East Jackson Blvd., Chicago, Ill., is architect.

Ia., Fort Dodge—Central State Light & Power Co., plans the construction of a hydro-electric plant and dam at Dolliver Park on the Des Moines River. Estimated cost $500,000. J. H. Leamy, is engineer.

Kan., Longton—City D. McCoy, Clk., awarded contract for waterworks improvements including purification plant, filter house, pump house, pumps, etc. to W. B. Carter, 1509 East Admiral St., Tulsa, Okla. Estimated cost $60,000.

Kan., Manhattan—Kansas State Agricultural College, will receive bids about Nov. 1 for the construction of a power and heating plant. Estimated cost $315,-000. C. D. Cuthbert, State House, Topeka, Kan., is architect.

Ky., Paducah—G. Langstaff, plans the construction of a 10 story hotel. Estimated cost $1,000,000. Marr & Holman, Stahlman Bldg., Nashville, Tenn., are architects.

Mich., Detroit—J. L. Hudson Co., Gratiot & Farmer Sts., awarded contract for a 16 story mercantile building on Woodward Ave. to Bryant & Detwiler Co., 2336 Dime Bank Bldg. Steam heating and ventilation systems, boilers, elevators, etc., will be installed.

Miss., Hattiesburg—Syndicate, c/o Hattiesburg Chamber of Commerce, T. S. Jackson, Secy., awarded contract for a 7 story hotel and theatre building at Forest and Pine Sts. to Selden-Breck Construction Co., Fullerton Bldg., St. Louis, Mo. Estimated cost $1,000,000.

Miss., Jackson—Mississippi Hospital Removal Improvements & Land Sale Comn., R. L. Brown, Secy., will soon award contract for the construction of a group of buildings including power house, etc., for Mississippi State Insane Hospital, N. W. Overstreet, is city architect.

Mo., Cabool—City plans an election soon to vote $39,000 bonds for waterworks improvements including reservoir, deep well pumping equipment, 60,000 gal. tank on tower, etc. A. W. Kendricks, Seymour, is engineer.

Neb., Wilber—City plans an election Oct. 24 to vote $35,000 bonds for the construction of a municipal light plant.

N. J., Carteret—F. L. Smith, 21 East 40th St., New York, N. Y., Engr., is receiving bids for the construction of saw mill conveyors and fuel house here, for I. T. Williams & Son, Woodbridge Ave. Estimated cost $60,000.

N. Y., Albany—Dept. of Health, Capitol, will soon award contract for the construction of a power house, etc. for State Division of Laboratories and Research.

N. Y., New York—Arezzo Corp., 20 Vesey St., awarded contract for a 14 story apartment building at 160 East 72nd St. to T. E. Rhoades Co., 342 Madison Ave. Estimated cost $1,000,000. Steam heating system, boilers, pumps, elevators, etc. will be installed.

N. Y., New York—M. Kurzrok, 550 7th Ave., is receiving bids for a 22 story hotel at 51st St. and 7th Ave. Estimated cost $1,600,000. Schwartz & Gross, 345 5th Ave., architects. Work will be done by separate contracts. Owner is general contractor.

N. Y., New York—Julius Tishman & Sons, 285 Madison Ave., will build a 15 story apartment building at Park Ave., and 81st St. Estimated cost $2,500,000. Schwartz & Gross, 347 5th Ave., are architects.

N. C., Greenville—East Caroline Teachers College awarded contract for the construction of a new power and heating plant to Poe Piping & Heating Co., Greenville, in connection with proposed college.

O., Cleveland—The Cleveland Hotel Co., Public Sq. and Superior St., plans an addition to hotel at Public Sq. Estimated cost $1,500,000. Graham, Anderson, Probst & White, 80 East Jackson Blvd., Chicago, Ill., are architects.

O., Cleveland—New York Central R.R., 466 Lexington Ave., New York, N. Y., had plans prepared for addition to engine house and fan room on East 152nd St. here. Estimated cost $80,000. F. B. Freeman, is chief engineer.

O., Cleveland—Rainbow Hospital, c/o M. B. Wilson, Supt., 2233 East 55th St., is receiving bids for the construction of a hospital including steam heating and ventilation systems, boilers, etc. on Richmond Rd. Estimated cost $500,000. Warner & McCormack, Bulkley Bldg., are architects.

O., Columbus—Y. W. C. A. Association, J. A. Beer, 236 Fifteenth Ave., awarded contract for an 8 story club building on South Fourth St. to Middle States Construction Co., 1237 Essex St. Estimated cost $600,000. Steam heating system, electric elevators, etc. will be installed.

Okla., Wewoka—Shawnee Ice Co., c/o E. W. Hill, Pres., Shawnee, is having preliminary plans prepared for extensions and improvements to ice plant to increase the capacity from 75 to 150 ton daily. Estimated cost $85,000. Equipment required.

Pa., Philadelphia—N. W. Ayers & Son, Third and Chestnut Sts., awarded contract for a 13 story office building at West Washington Sq., to Ketcham & McQuaid, 1029 Brown St. Estimated cost $1,600,000.

Pa., Philadelphia—R. N. Dippy, 1601 Walnut St., Archt., is receiving bids for the construction of a 15 story apartment including steam heating system, etc. at 9th and Chestnut Sts., for Sixty Ninth Realty Co.

Tenn., Memphis—U. S. Veterans Bureau, Arlington Bldg., Washington, D. C., will receive bids until Oct. 25 for the construction of a refrigeration plant at U. S. Veterans Hospital here.

Texas—Central Power & Light Co., Frost Bldg., San Antonio, is having preliminary plans prepared for the construction of cold storage plants at Olmito, Donna and Sebastian. Estimated cost $30,000, $30,000 and $40,000 respectively.

Tex., Brownsville—Central Power & Light Co., c/o Frost Bldg., San Antonio, has acquired a site and plans the construction of a cold storage plant here. Estimated cost $40,000. Private plans.

Tex., Eagle Pass—Crystal Ice Co., plans the construction of a 30 ton ice plant to replace fire loss. Estimated cost $35,000. Private plans. Electrically operated machinery will probably be required.

Tex., Plemons—Phillips Petroleum Co., Bartlesville, Okla., plans the construction of a pumping plant on Big Creek to divert about 475 acre ft. of water here. Estimated cost $75,000. Private plans.

Tex., Pyote — Chamber of Commerce plans the construction of an ice and cold storage plant.

Tex., Quanah — Texas Utilities Co., Abilene, has acquired the Quanah Light & Ice Co's plant and plans extensions and improvements here. Estimated cost $35,000. Engineer not selected. New machinery will be required.

Tex., Sweetwater—Citizens Ice Co., c/o G. Sample, Mgr., plans the construction of a 25 ton ice plant and 100 ton cold storage plant. Estimated cost $40,000. Private plans. Machinery and equipment will be required.

Ont., Ottawa—Canadian National R.R., Montreal, Que., awarded general contract for addition of Chateau Laurier Hotel on Rideau St. here to Foundation Co. Ltd., 746 Sherbrooke St. W., Montreal, Que.

Equipment Wanted

Boiler—City of Los Angeles, Calif., will receive bids until Oct. 17 for a 306 hp. water tube boiler complete with burners.

Engine, Pump and Boiler—Water Board, c/o W. D. Masterton, San Antonio, Tex., will receive bids until Oct. 21 for a 20,000,-000 g.p.m. steam turbine engine, pump and boiler for proposed waterworks improvements. Estimated cost $75,000.

Generator — Heltonville Limestone Co., Bedford, Ind., is in the market for a 75 kw. motor generator, 250 v. d.c., 3 ph., 60 cycle.

Generator Sets — Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids until Oct. 26 for motor generator sets for Navy Yard, Puget Sound, Wash.

Hydraulic Turbines — Direction General de Obras Publicas, E. Ortega, Engr., in charge of Construction, Santo Domingo, Dominican Republic, prices and catalogs on hydraulic turbines for generation of electric lighting and electric energy.

Pumping Equipment—City of Kingfisher, Okla., will be in the market for pumping equipment, etc. for proposed waterworks system. Estimated cost $150,000.

Pumping Equipment—J. B. Davis, Mayor, Rock Hall, Md., will receive bids until Oct. 17, for furnishing and installing temporary pumping equipment for waterworks.

Pumps and Motors—D. R. Fraser, Clk., Wewoka, Okla., will receive bids until Nov. 4 for two 1,000 g.p.m. pumps and motors, etc. for proposed waterworks system. Estimated cost $125,000.

Pumps, Motors, Etc.—F. H. McFarland, Mayor, Cocoa, Fla., will receive bids until Oct. 14, for two 500 g.p.m. and one 250 g.p.m. centrifugal pumps, four 120 g.p.m. triplex pumps, two 40 hp., one 7½ hp. and four 3 hp. electric motors, etc. for proposed filter plant.

Pumps, Motors, Transformers, Etc.—City of Muskegon, Mich., is in the market for three 6,000,000 g.p.m. centrifugal motor driven pumps, three 200 hp. a.c. motors, one 225 hp. gasoline engine, three transformers, oil switch, etc. for proposed electrifying of waterworks plant.

Steam Heating and Coal and Ash Handling Equipment, etc.—Bd. of Education, J. E. Byrnes, Chicago, Ill., will receive bids until Oct. 13 for steam heating and coal and ash conveyor equipment, etc., for Manley Jr. High School.

Steam Heating and Oil Burning Equipment—Dept. of Public Works, Bureau of Water, Philadelphia, Pa., will receive bids until Oct. 18 for steam heating and oil burning equipment for three existing 325 hp. boilers for Torresdale pumping station. Cont. 901.

Steel Wire and Rope Sheaves—Norton Electric Supply & Equipment Co., Norton, Va., prices and catalogs on rubber insert steel wire and rope sheaves, 4 to 5 ft. in diameter.

Transformers and Electric Light Cable, Etc.—M. J. Kennedy, Comr., of Gas & Electricity, City Hall, Chicago, Ill., will receive bids until Oct. 10 for 4.2 kva. manhole type transformers, aluminum bracket fixtures and pole and manhole type series transformers for 1,000 C.P. lamps and electric light cable of various kinds, for proposed extension to municipal lighting system.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

HIGHER prices prevail, than at this time last month, in rubber-covered copper wire and leather belting in the New York market. Slight upward tendencies are reported in pipe and boiler covering. Minimum on boiler rivets is 10c. per 100 lb. below the September level at Pittsburgh mills. Genuine, highest grade babbitt metal declined 5c. per lb. during the month. A drop of ½c. per lb. occured in No. 4 babbitt, while intermediate grades remained firm. Lower prices than a month ago are obtainable in brass-shell sockets and non-refillable fuses in standard package lots.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		(net) 68c. per ft.
Common, 2½-in., cotton-rubber lined	80c. per ft. list less	50%

Air—Best grade

¾-in., per ft.	3-ply....$0.34	4 ply....$0.42

Steam—Discounts from List

First grade.....40% Second grade.....40–5% Third grade.....50%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade.....50% Second grade.....50–10%

LEATHER BELTING—List price, 24c. per lin.ft. per inch of width for single ply at New York warehouses.

Grade	Discount from list
Medium	35%
Heavy	30%

RAWHIDE LACING—For cut, best grade, 50%, 2nd grade, 60%. For laces in sides, best, 41c. per sq.ft.; 2nd, 37c. Semi-tanned: cut, 50%; sides, 41c. per sq.ft.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.95
Asbestos for high-pressure steam, ⅛ in.	1.75
Duck and rubber for piston packing	.95
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.30
Rubber sheet	.50
Rubber sheet, wire insertion	.80
Rubber sheet, duck insertion	.60
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
Asbestos, air cell, for low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.35 per bbl. without bags, in carload lots delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.34 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York	Cleveland	Chicago
White	10.00@13.50	16.00	15.00@20.00
Colored	9.00@13.00	12.00	12.00@17.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed, white wipers, as follows:

Chicago	$0.15
New York	.15½
Cleveland (per 100 sq.ft.)	36.00

LINSEED OIL—These prices are per 7½-lb. gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$0.86½	$0.94	$0.78

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	$13.75	$15.25	$15.25	$16.75
White	13.75	15.25	13.75	15.25

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Tank rivets, ⅞-in., dia. and smaller, list (Apr. 1, 1927) less 50-10% in full keg lots. EXTRA per 100 lb. for ½-in. dia., 35c.; ⅝-in., 15c.; 1-in., 5c.; lengths, 1-in. and shorter, 25c.; longer than 1-in. up to and including 1⅛-in., 15c.; longer than 5-in., 25c.; standard countersunk head, 25c.

Structural rivets, per 100 lb.:
New York..... $5.00* Chicago... $3.60 Pittsburgh mill $2.75@$3.00

Cone-head boiler rivets, per 100 lb.:
New York..... $5.00* Chicago... $3.60 Pittsburgh mill $3.00

*Full keg lots.

REFRACTORIES—Prices in car-load lots, f.o.b. plant:

Chrome brick, eastern shipping points	net ton	$45.00
Chrome cement, 40@50% Cr_2O_3, in bulk	net ton	22@25
Chrome cement, 40@50% Cr_2O_3, in sacks	net ton	26@29
Magnesite brick, 9-in. straights	net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	net ton	71.50
Magnesite brick, Soaps and splits	per ton	91.00
Silica brick, Mt. Union, Pa.	per M	43.00
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38
Chrome ore crude, 40@50%	net ton	18.00@22.50

BABBITT METAL—Delivered, New York, cents per lb.:

Genuine, highest grade	78.00
Commercial genuine, intermediate grade	61.00
Anti-friction metal, general service	31.50
No. 4 babbitt (f.o.b.)	12.50

COLD DRAWN STEEL—Warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Shafting and screw stock, round and hexagon	$4.00	$3.65	$3.60
Flats and squares	4.50	4.15	4.10

BOILER FITTINGS—F. o. b. New York or Jersey City, discounts from list:

	Current
Copper ferrules	70%
Boiler flanges	65-5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following basing discounts are to jobbers for car-load lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	47½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are net prices per 100 ft. in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers.

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17 07
1¼	.....	.....	19 20
1½	.....	$38 00	17 92
1¾	.....	28 50	20 48
2	$17 33	25 00	20 24
2¼	19 84	28 25	23 00
2½	21 60	34 00	26 03
3	25 50	42 50	27 04
3½	30 25	49 50	30 67
3½	31 50	52 75	33 33
4	38 03	67 00	40 11

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.
These prices are net per 100 ft. based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.
In addition to the above, standard cutting charges are as follows:

2 in. and smaller,	5c. per cut.	3 in.,	9c. per cut
2¼ and 2½ in.,	6c. per cut.	3¼ to 4 in.,	10c. per cut

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent. 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$30.00 (net)	$46.00 (net)	$180.00	$220.00
No. 12 solid	136.00	180.00	225.00	275.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	305.00	375.00	420.00	500.00
No. 6 stranded	440.00	530.00	615.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	50%	20%
Coils to 1,000 ft.	60%	30%
1,000 to 5,000 ft.	65%	35%
5,000 ft. and over	67½%	38%

CONDUIT—Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$56.50	$61.34	$7.76	$8.83	$4.52	$4.92
⅜	72.07	78.63	10.21	11.63	6.46	7.03
1	103.31	113.00	15.10	17.21	8.39	9.13
1¼	139.77	152.88	20.51	23.07	11.78	12.75
1½	167.12	182.79	27.34	30.76	14.56	15.75
2	224.85	245.94	50.13	56.40	19.41	21.01
2½	355.50	388.85	82.03	92.28	27.73	30.01
3	464.88	508.50	218.74	246.10	41.59	45.01
3½	585.30	637.74	483.04	543.46	55.46	60.02
4	714.17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG, SOLID NEUTRAL OR 2 FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID NEUTRAL OR 2 FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$17.75
No. 16 cotton reinforced heavy		22.00
No. 18 cotton reinforced light		14.50
No. 16 cotton reinforced light		18.35
No. 18 cotton Canvasite cord		14.75
No. 16 cotton Canvasite cord		17.20
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$72.00	*80.00
No. 14 super service cord or similar (2 wire) in 1,000 ft.	110.00	*122.00

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.15	3-amp. to 30-amp.	100	$0.30
35-amp. to 60-amp.	100	.30	35-amp. to 60-amp.	100	.60
61-amp. to 100 amp.	50	.90	65-amp. to 100-amp.	50	1.50
101-amp. to 200-amp.	25	2.00	110-amp. to 200-amp.	25	2.50
201-amp. to 400-amp.	25	3.60	225-amp. to 400-amp.	25	5.50
401-amp. to 600-amp.	10	5.50	450-amp. to 600-amp.	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 64%; standard package, 70%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carto Quantit
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
REFILLS—				
1 to 30-amp	$0.03 ea.	$0.05	100	100
35 to 60-amp.	.05 ea.	.06	100	100
65 to 100-amp.	.10 ea.	.10	50	50
110 to 200-amp.	.15 ea.	.15	25	50
225 to 400-amp.	.30 ea.	.30	25	25
450 to 600-amp.	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than standard pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500)	$2.75
0-30 ampere, less than standard package	3.00

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard A type bulbs:

100—130 Volt Watts	Type	Price Each	200—260 Volt Watts	Type	Price Each
15	A 17	$0.23		Special	
	General		25	A 19	$0.28
25	A 19	.23	50	A 21	.28
40	A 21	.23	100	A 23	.50
50	A 21	.25			
60	A 21	.25			
100	A 23	.40			

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.18
Composition 2-piece attachment plug	.27
Swivel attachment plug	.12
Small size—2 Pc. Plug—Composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$6.00	$9.30	$10.90	$17.50
12	9.95	12.50	14.50	24.60
10	13.20	16.25	18.30	31.00
8	19.10	22.50	24.00	43.00
6	.....	.....	33.75	.....
4	.....	.....	47.50	.....
2	.....	.....	66.75	.....
1	.....	.....	92.00	.....
0	.....	.....	113.00	.....
00	.....	.....	134.50	.....
000	.....	.....	161.00	.....
0000	.....	.....	191.50	.....

SOCKETS, BRASS SHELL—Price each, net:

	¼ In. or Pendant Cap Key	¼ In. or Pendant Cap Keyless	¼ In. or Pendant Cap Pull	⅜ In. Cap Key	⅜ In. Cap Keyless	⅜ In. Cap Pull
Standard package	$0.14	$0.12	$0.20	$0.17	$0.15	$0.23
Unbroken carton	.16	.14	.21	.19	.17	.24
Broken carton	.18	.16	.24	.21	.19	.27

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb., 31c. lb.; 100 lb. lots	29c lb.
Rubber tape, ¾ in., less 100 lb., 33c. lb.; 100 lb. lots	31c lb.
Wire solder, less 100 lb., 33c. lb.; 100 lb. lots	31c. lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25.00 to $50.00 list value	30–5%
$50.00 list value or over	35%